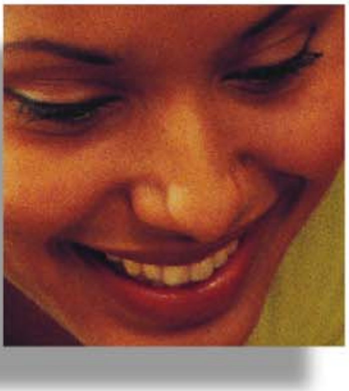
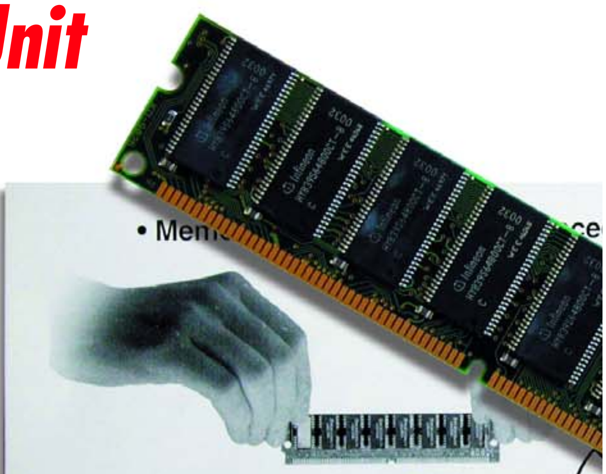
CHAPTER 4

The Components of the System Unit





The doorbell rings. As you open the door, your niece and nephew politely greet you and then head straight for the computer. Weekend visits have become part of their regular routine. You would like to think it is because of your great personality! The real draw is your computer and all the cool game software.

Lately, though, you have heard complaining. Videos and actions on the screen are choppy. The computer is slow, and it freezes in the middle of some programs.

What can you do? You cannot afford a new computer. A visit to the electronics store where you purchased the computer seems like the solution. After explaining the situation to a technician, she suggests you upgrade the memory inside the computer for a cost of a hundred dollars. It sounds great, but you have one very big problem. You do not have the slightest idea how to install memory inside a computer. The technician assures you the memory upgrade kit includes thorough instructions with detailed pictures. The store also has a 24-hour toll-free help line.

Leaving the store with the upgrade memory kit in hand, you will tackle this project on the weekend — when you can recruit help from your niece and nephew!

OBJECTIVES

After completing this chapter, you will be able to:

- Describe the components in the system unit
- Explain how the CPU uses the four steps of a machine cycle to process data
- Compare and contrast various personal computer processors on the market today
- Define a bit and describe how a series of bits represents data
- Differentiate between the various types of memory
- Describe the types of expansion slots and cards in the system unit
- Explain the difference between a serial, a parallel, and a USB port
- Describe how buses contribute to a computer's processing speed
- Identify components in a notebook computer
- Identify components in a handheld computer

THE SYSTEM UNIT

Whether you are a home or a business user, you most likely will make the decision to purchase a new computer or upgrade an existing computer within your lifetime. Thus, understanding the purpose of each component in a computer is important. As discussed in Chapter 1, a computer includes devices used for input, processing, output, storage, and communications. Many of these components reside in the system unit.

The **system unit** is a box-like case that houses the electronic components of the computer used to process data. Sometimes called a **chassis**, the system unit is made of metal or plastic and protects the internal electronic components from damage. All computers have a system unit (Figure 4-1).

On a personal computer, the electronic components and most storage devices reside inside the

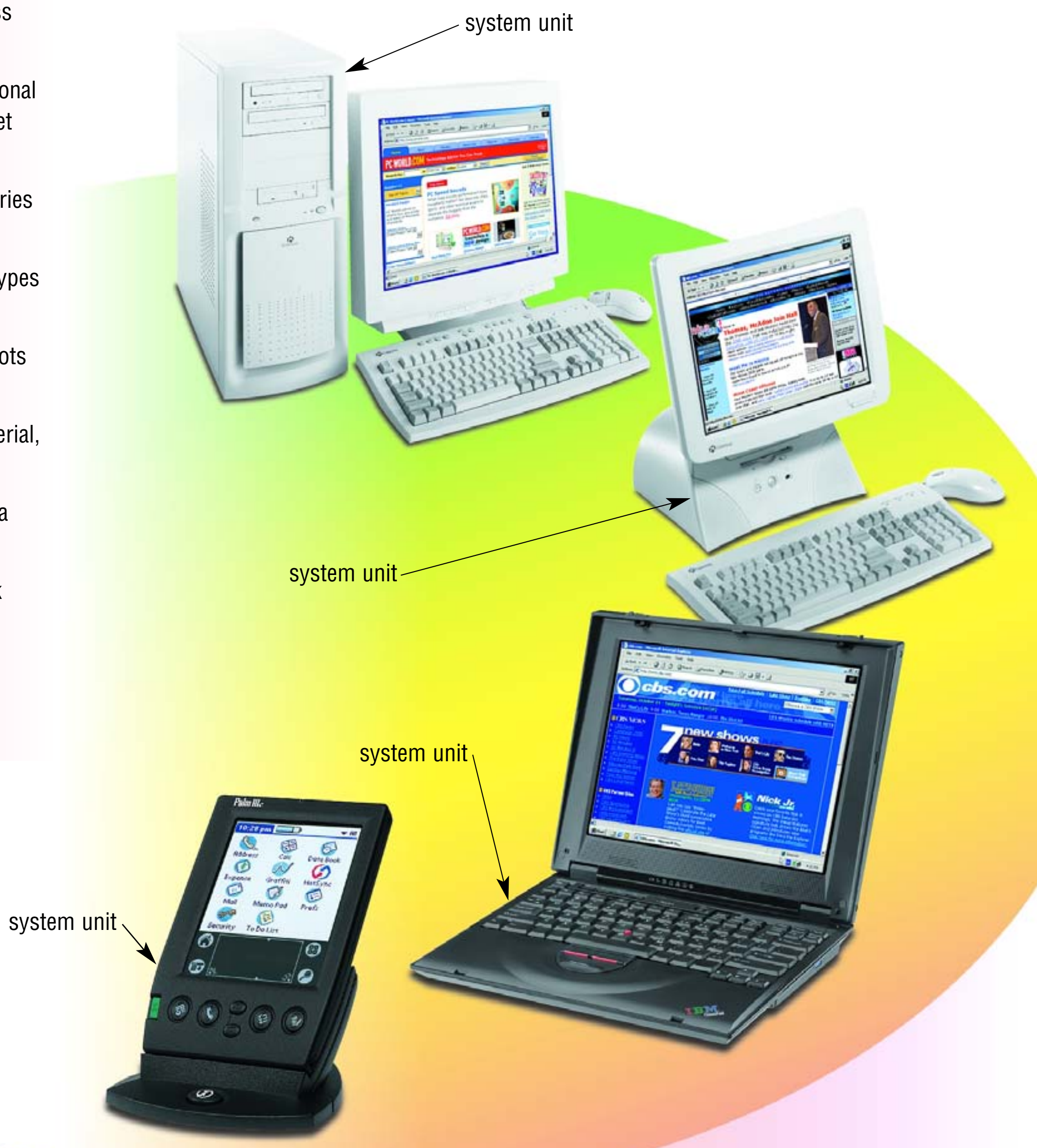


Figure 4-1 All sizes of computers have a system unit.

system unit. Other devices, such as a keyboard, mouse, microphone, monitor, printer, speakers, scanner, and PC camera normally occupy space outside the system unit. On a desktop personal computer, the system unit usually is a device separate from the monitor and keyboard. Some system units sit on top of a desk. Other models, called **tower models**, can stand vertically on the floor.

To conserve on space, an **all-in-one computer** houses the system unit in the same physical case as the monitor. On notebook computers, the keyboard and pointing device often occupy the area on the top of the system unit. The display attaches to the system unit by a hinge. The system unit on a handheld computer usually consumes the entire device. On these devices, the display is part of the system unit too.

At some point, you might have to open the system unit on a desktop personal computer to replace or install a new component. For this reason, you should be somewhat familiar with the inside of the system unit.

Figure 4-2 identifies some of the components inside a system unit on a desktop personal computer. Components inside the system unit include the processor, memory module, cards, ports, and connectors. The

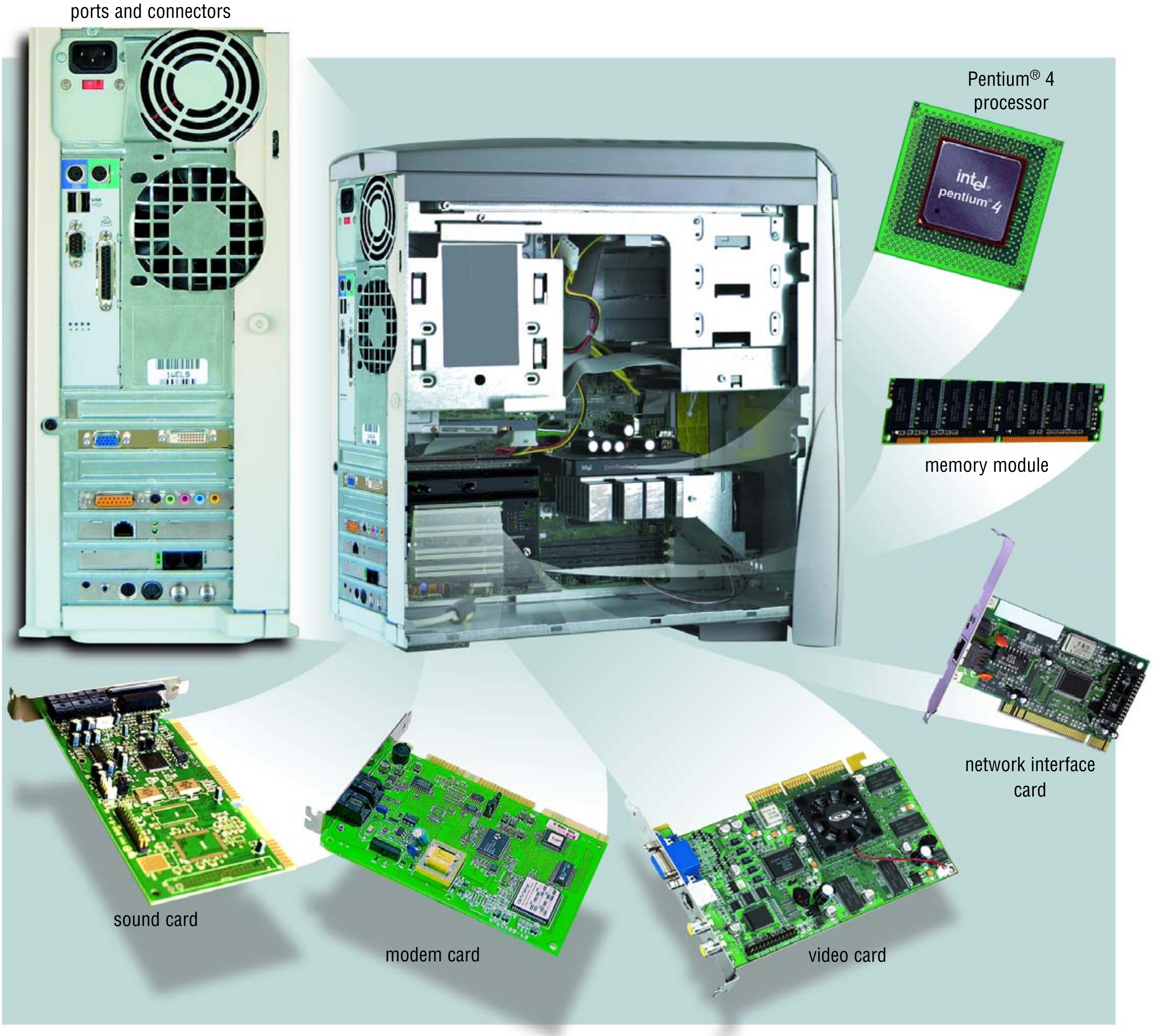


Figure 4-2 Some of the components inside the system unit on a typical personal computer are shown in this figure.

processor interprets and carries out the basic instructions that operate a computer. A memory module is a package that houses memory. Memory temporarily holds data and instructions. A card, also called an expansion card, is a circuit board that adds devices or capabilities to the computer. Four types of cards found in most desktop personal computers today are a sound card, a modem card, a video card, and a network interface card.

Devices outside the system unit attach to a port on the system unit by a cable. These devices may include a keyboard, mouse, microphone, monitor, printer, scanner, speakers, and PC camera.

Web Link

For more information on motherboards, visit the Discovering Computers 2002 Chapter 4 WEB LINK page (**scsite.com/dc2002/ch4/weblink.htm**) and click Motherboards.

The Motherboard

The **motherboard**, sometimes called **system board**, is the main circuit board in the system unit. Figure 4-3 shows a photograph of a desktop personal computer motherboard and identifies some of its components, including different types of chips.

A **chip** is a small piece of semi-conducting material, usually no bigger than one-half-inch square, on which integrated circuits are etched. An **integrated circuit** (**IC**) is a microscopic pathway capable of carrying electrical current. Each integrated circuit can contain millions of elements such as transistors. A **transistor** acts as an electronic switch, or gate, that opens or closes the circuit for electronic signals.

Manufacturers package chips so the chips can be attached to a circuit board such as a motherboard, memory module, or card. A variety of chip packages exist (Figure 4-4). One type, called a **dual inline package** (**DIP**), consists of two parallel rows of downward-pointing thin metal feet (pins). The pins attach the chip package to the circuit board. A **pin grid array** (**PGA**) **package** holds a larger number of pins because the pins are mounted on the surface of the package. A **flip chip-PGA** (**FC-PGA**) **package** is a higher-performance PGA packaging that places the chip on the opposite side (flip side) of the pins. Another high performance packaging technique does not use pins. A **single edge contact** (**SEC**) **cartridge** connects to the motherboard on one of its edges.

The motherboard contains many different types of chips. Of these, one of the most important is the processor, also called the central processing unit (CPU).

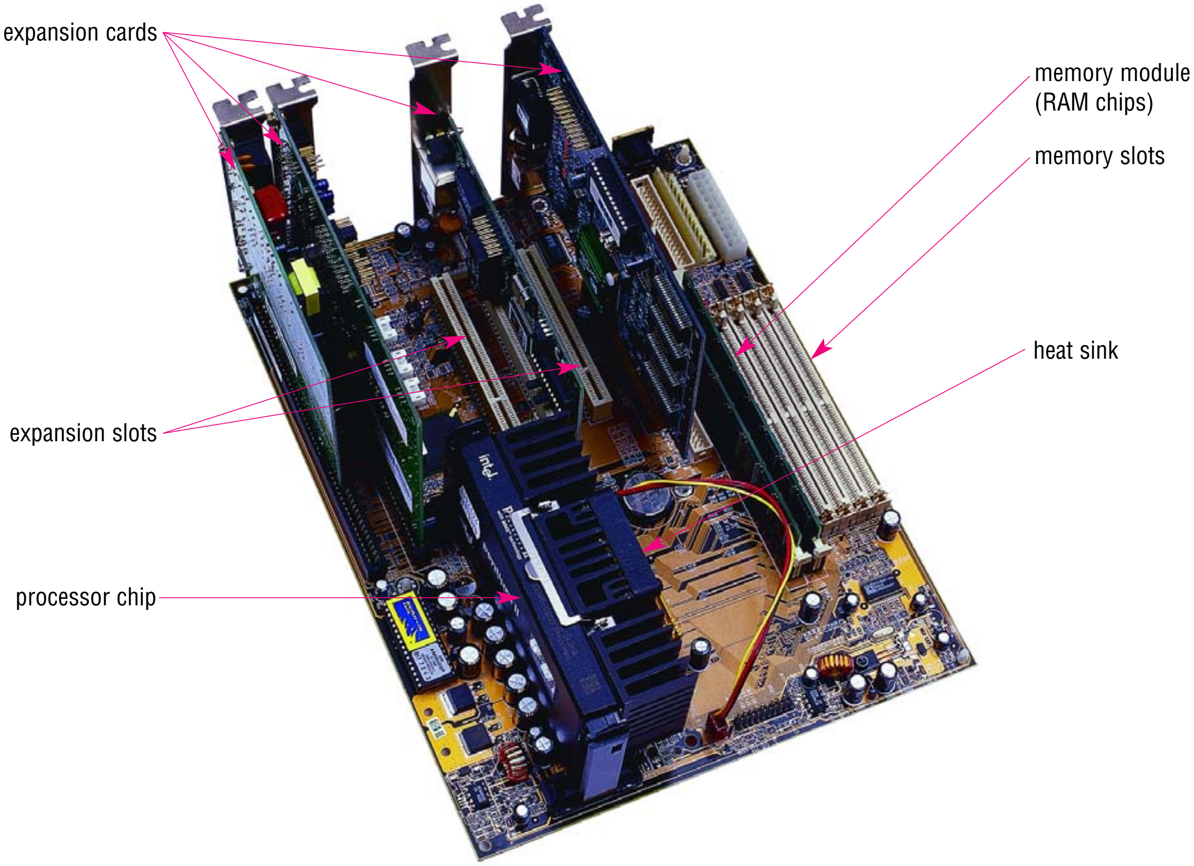


Figure 4-3 The motherboard in a desktop personal computer contains chips and many other electronic components.

CENTRAL PROCESSING UNIT

The **central processing unit** (**CPU**), often called a **processor**, interprets and carries out the basic instructions that operate a computer. The CPU significantly impacts overall computing power and manages most of a computer's operations. Most of the devices connected to the computer communicate with the CPU in order to carry out a task (Figure 4-5).

The CPU contains the control unit and the arithmetic/logic unit. These two components work together to perform processing operations.

The Control Unit

The **control unit**, one component of the CPU, directs and coordinates most of the operations in the computer. The control unit has a role much like a traffic cop: it interprets each instruction issued by a program and then initiates the appropriate action to carry out the instruction.

For every instruction, the control unit repeats a set of four basic operations: (1) fetching, (2) decoding, (3) executing, and, if necessary, (4) storing. **Fetching** is the process of obtaining a program instruction or data item from memory. **Decoding** is the process of translating the instruction into commands the computer can execute. **Executing** is the process of carrying out the commands. **Storing** is the process of writing the result to memory.

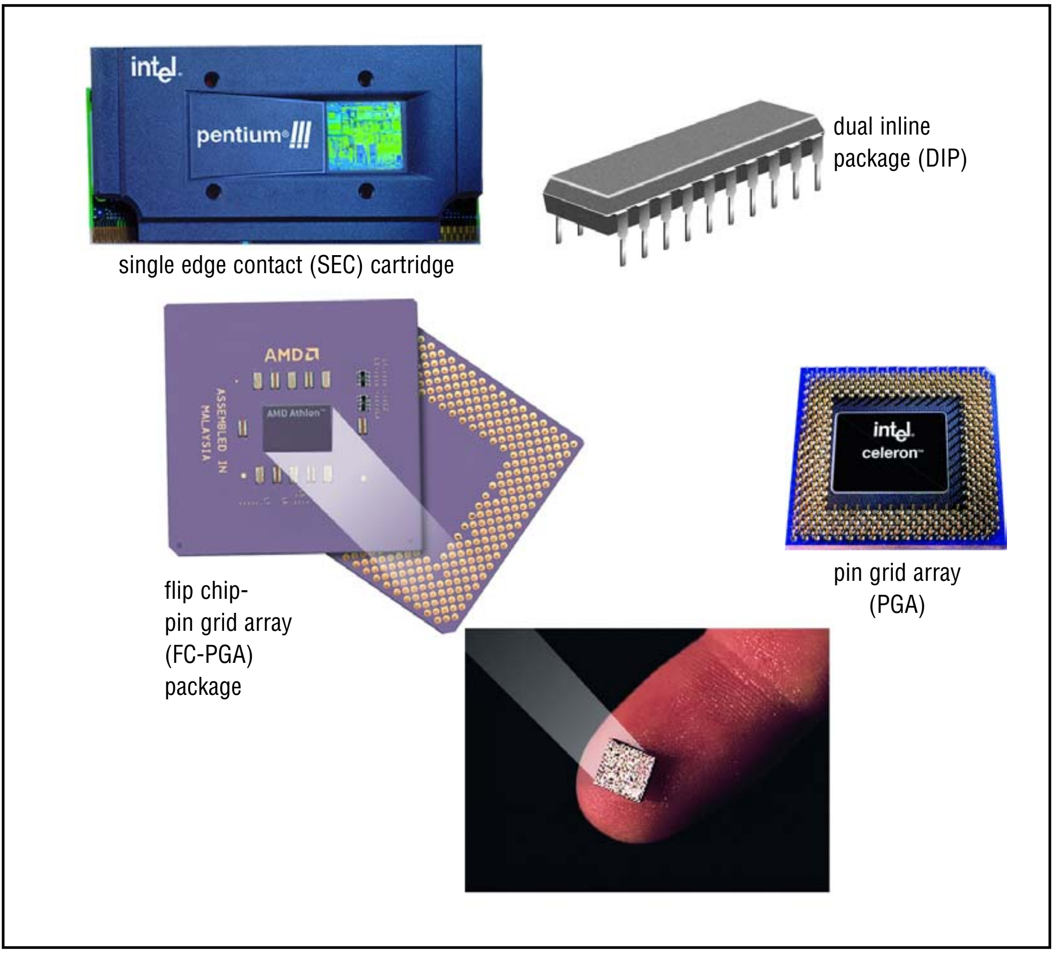

intel
pentium III
single edge contact (SEC) cartridge
dual inline package (DIP)
AMD
AMD Athlon
ASSEMBLED IN MALAYSIA
flip chip-pin grid array (FC-PGA) package
intel
celeron
pin grid array (PGA)

Figure 4-4 Various chip packages.

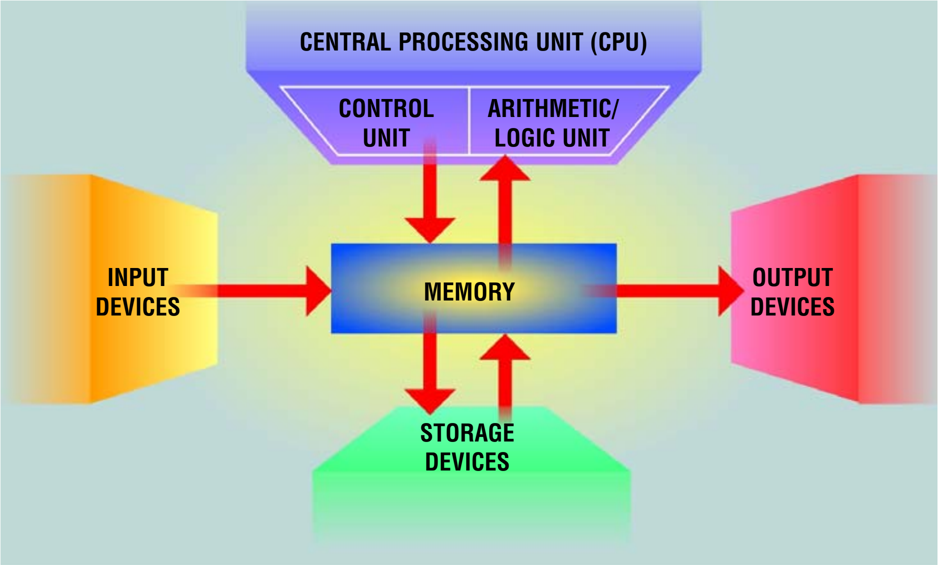


Figure 4-5 Most of the devices connected to the computer communicate with the CPU in order to carry out a task. The arrows in this figure represent the flow of data, instructions, and information.

Together, these four operations (fetching, decoding, executing, and storing) comprise a **machine cycle** or **instruction cycle** (Figure 4-6). **Instruction time (i-time)** is the time it takes the control unit to fetch and decode. **Execution time (e-time)** is the time it takes the control unit to execute and store. You can compute the total time required for a machine cycle by adding together the i-time and e-time.

Some computer professionals measure a CPU's speed according to how many **m**illions of **i**nstructions **p**er **s**econd (**MIPS**) it can process. Current desktop personal computers, for example, can process more than 300 MIPS. No real standard for measuring MIPS exists, however, because different instructions require varying amounts of processing time.

CPUs use either a CISC or RISC design. **CISC** (**complex instruction set computing**) supports a large number of instructions. **RISC** (**reduced instruction set computing**) reduces the instructions to only those used more frequently. A RISC CPU executes simple instructions more quickly than a CISC CPU. A CISC CPU executes complex instructions more quickly than a RISC CPU.

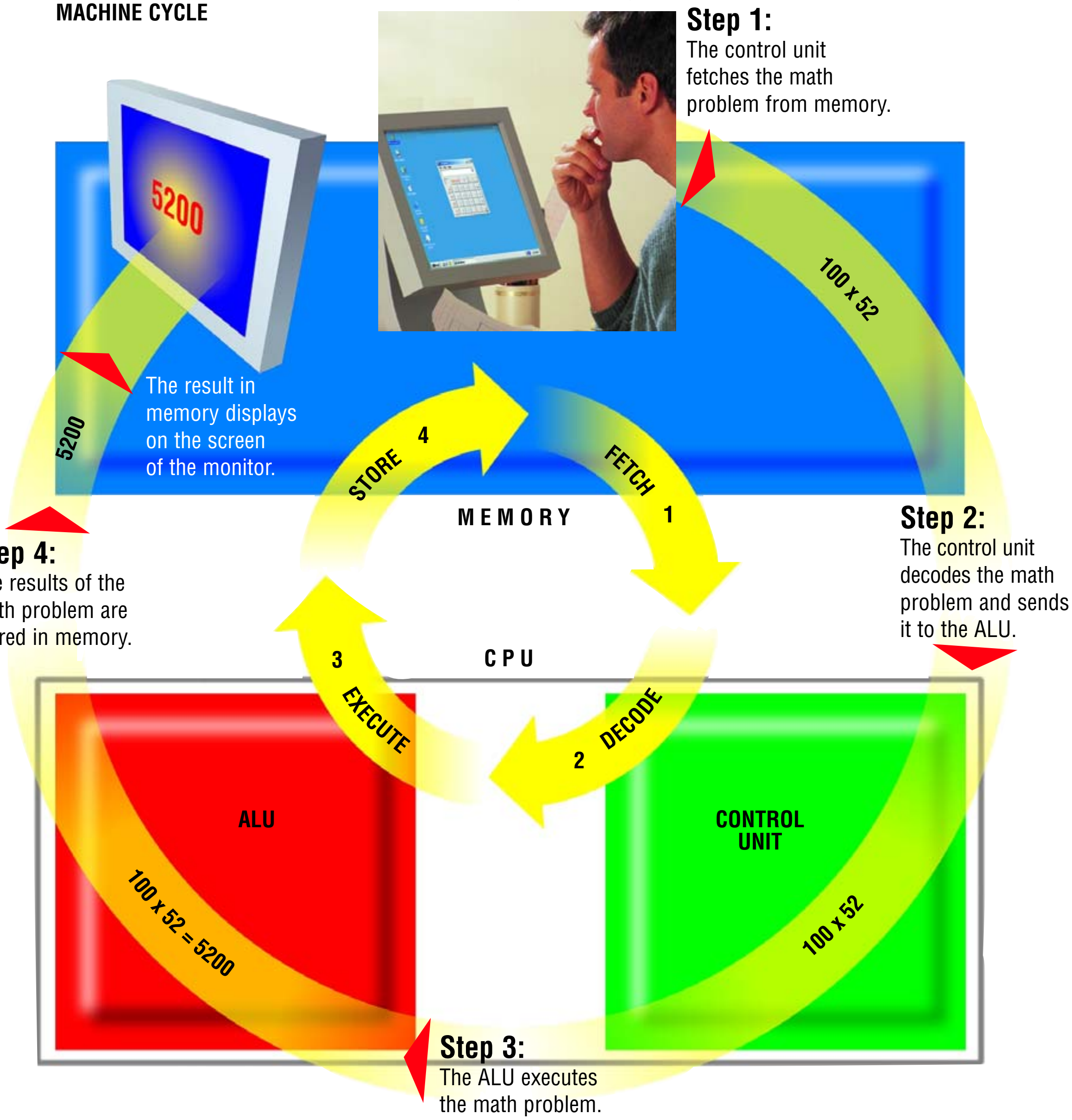
The Arithmetic/Logic Unit

The **arithmetic/logic unit** (**ALU**), another component of the CPU, performs arithmetic, comparison, and logical operations.

Arithmetic operations include addition, subtraction, multiplication, and division.

Comparison operations involve comparing one data item to another to determine if the first item is greater than, equal to, or less than the other item. Depending on the result of the comparison, different actions may occur. To determine if an employee should receive overtime

Figure 4-6 THE STEPS IN A MACHINE CYCLE



A student enters a math problem into the memory of the computer.

Step 1: The control unit fetches the math problem from memory.

Step 2: The control unit decodes the math problem and sends it to the ALU.

Step 3: The ALU executes the math problem.

Step 4: The results of the math problem are stored in memory.

The result in memory displays on the screen of the monitor.

pay, the ALU compares the number of hours an employee worked during the week to the regular time hours allowed (40 hours, for instance). If the hours worked is greater than 40, the ALU calculates an overtime wage. If hours worked is not greater than 40, the ALU does not calculate an overtime wage.

Logical operations use conditions along with logical operators such as AND, OR, and NOT. For example, if only non-salaried employees can receive overtime pay, the ALU must verify that the employee is non-salaried AND worked more than 40 hours before computing an overtime wage.

Pipelining

In some computers, the CPU processes only one instruction at a time. In these computers, the CPU waits until an instruction completes all four stages of the machine cycle (fetch, decode, execute, and store) before beginning work on the next instruction.

With **pipelining**, the CPU begins executing a second instruction before it completes the first instruction. Pipelining results in faster processing because the CPU does not have to wait for one instruction to complete the machine cycle before fetching the next. Think of a pipeline as an assembly line. By the time the first instruction is in the last stage of the machine cycle, three other instructions could have been fetched and started through the machine cycle (Figure 4-7).

Although formerly used only in high-performance computers, today's personal computers commonly use pipelining. Most current personal computer CPU chips can pipeline up to four instructions.

Registers

The CPU contains high-speed storage locations, called **registers**, that temporarily hold data and instructions. A CPU has many different types of registers, each with a specific function. These functions include storing the location from where an instruction was fetched, storing an instruction while the control unit decodes it, storing data while the ALU processes it, and storing the results of a calculation.

ISSUE

Our Brain versus the Computer

Functions of the Control Unit

The control unit's function is to direct and coordinate most of the operations in the computer. For each instruction, the control unit repeats a set of four operations: fetching, decoding, executing, and storing. These four operations may seem new to you, but in a sense you carry out these same operations each time you complete certain ordinary tasks. You input data through one of your five senses; you decode this data, changing it into information; you execute the task in some way; and you store this information for later retrieval. Do people solve problems the same way in which a computer solves a problem? Do you agree that the human brain is similar to a computer? Why or why not? Describe a simple task in which you perform operations like those in the machine cycle. What is different and why? If the human brain can perform all of these functions, do we really need computers? Explain your answer.

For more information on the control unit vs. the human brain, visit the Discovering Computers 2002 Issues Web page (**scsite.com/dc2002/issues.htm**) and click Chapter 4 Issue #1.

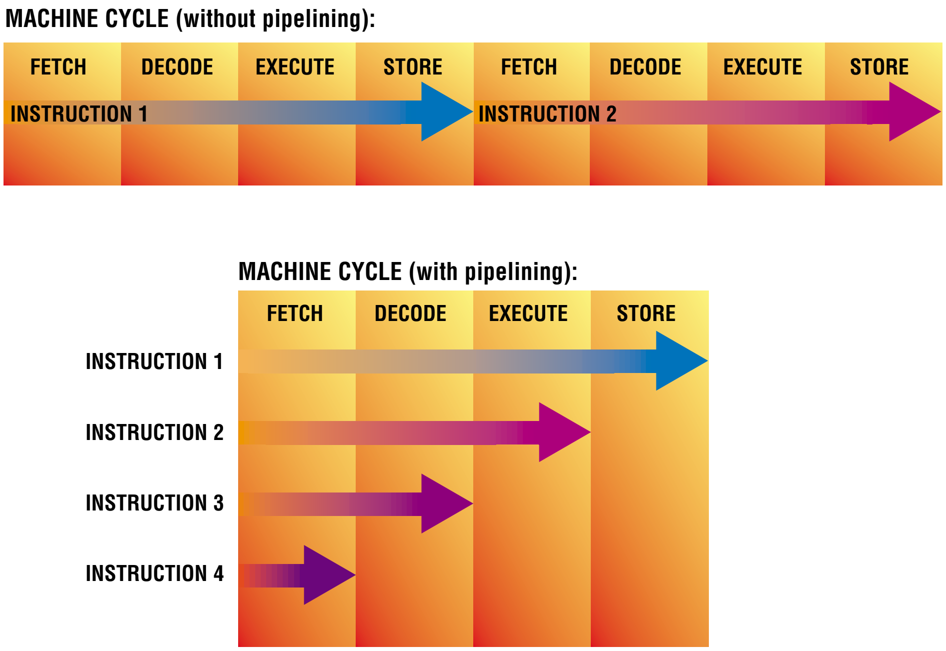


Figure 4-7 Most modern personal computers support pipelining. With pipelining, the CPU begins executing a second instruction before the first instruction is completed. The result is faster processing.

APPLY IT!

Clock Speed – How Much Is Enough?

If you have considered purchasing a computer recently, you are aware of the many available models and that each of these models provides several options from which to choose. The market for personal computer hardware is incredible, making your options on what type of machine you want to buy just as impressive. One primary option to consider is processing power. What clock speed should you purchase? Do you need the latest and greatest dream machine? Is 1 GHz necessary for your processing needs or can you accomplish as much with less power? How fast do you want to go? The answers to these questions are directly related to how you intend to use the computer and what software applications you need. You can select a machine just for the basics or select one used by professional graphic artists or game players.

- Level I – Below 600 MHz
  This computer should provide more than adequate processing power for at least the next couple of years for the typical home user — someone who primarily uses a standard Office suite, edits home photographs, and plays a game now and then.
- Level II – 600 MHz to 1 GHz
  If your interest is in graphics and design, you play some of the multimedia games that include simulated 3-D and virtual reality, or you use voice recognition, your needs would be met best by a Level II computer.
- Level III – 1 GHz and above
  This computer is for the power user. If your goal is to create 3-D applications, run sophisticated graphics software or CAD programs, then you definitely want to purchase the fastest computer you can afford.

For more information on computer processing power, visit the Discovering Computers 2002 Apply It Web page (**scsite.com/dc2002/apply.htm**) and click Chapter 4 Apply It #1.

The System Clock

The CPU relies on a small chip called the **system clock** to synchronize, or control the timing of, all computer operations. Just as your heart beats at a regular rate to keep your body functioning, the system clock generates regular electronic pulses, or ticks, that set the operating pace of components in the system unit.

Each tick is a **clock cycle**. In the past, CPUs used one or more clock cycles to execute each instruction. Many of today's CPUs are **superscalar** and can execute more than one instruction per clock cycle.

Clock speed, also called **clock rate**, is the speed at which a processor executes instructions. The faster the clock, the more instructions the CPU can execute per second. Manufacturers state clock speed in megahertz and gigahertz. A **hertz** is one cycle per second. Mega is a prefix that stands for million. Giga is a prefix that stands for billion. Thus, **megahertz** (**MHz**) equates to one million ticks of the system clock, and **gigahertz** (**GHz**) equates to one billion ticks of the system clock. A computer that operates at 933 MHz (*megahertz*) has 933 million (*mega*) clock cycles in one second (*hertz*). The table in Figure 4-8 identifies these and other prefixes commonly used in the computer industry.

The power of a CPU frequently is determined by how fast it processes data. The system clock is one of the major factors that influence a computer's speed. A CPU with higher clock speed can process more instructions per second than a CPU with a lower clock speed. For example, a 1 GHz CPU is faster than a CPU operating at 800 MHz. Keep in mind that the speed of the system clock affects only the CPU. It has no effect on peripherals such as a printer or disk drive.

The speed of the system clock varies among CPUs. A technological breakthrough by IBM enables CPUs today to operate at speeds well beyond 400 MHz. For nearly 30 years, aluminum was used to create the electronic circuitry on a single chip of silicon crystal. Now, a process exists that uses copper instead of aluminum. CPU chips that use copper run faster because copper is a better conductor of electricity. An added benefit is these chips cost less. They also require less electricity, making them ideal for use in portable computers and other battery-operated devices.

COMMON PREFIXES AND THEIR MEANINGS

Prefixes for Small Amounts	Meaning	Decimal Notation
MILLI	One thousandth of	.001
MICRO	One millionth of	.000001
NANO	One billionth of	.000000001
PICO	One trillionth of	.000000000001

Prefixes for Large Amounts	Meaning	Decimal Notation
KILO	One thousand	1,000
MEGA	One million	1,000,000
GIGA	One billion	1,000,000,000
TERA	One trillion	1,000,000,000,000

Figure 4-8 The table above outlines prefixes commonly used in the computer industry.

Web Link

For more information on clock speed, visit the Discovering Computers 2002 Chapter 4 WEB LINK page (**scsite.com/dc2002/ch4/weblink.htm**) and click Clock Speed.

Comparison of Personal Computer Processors

On larger computers, such as mainframes and supercomputers, the various functions performed by the CPU, also called a processor, span many separate chips and sometimes multiple circuit boards. On a personal computer, because all functions of the processor usually are on a single chip, some call the chip a **microprocessor**. Most advertisements, however, refer to the chip as a processor. Figure 4-9 shows several popular personal computer processors.

Manufacturers often identify their personal computer processors by a model name or model number. Figure 4-10 summarizes the historical development of the personal computer processor and documents the increases in clock speed and number of transistors in chips since 1982. The greater the number of transistors, the more complex and powerful the chip.

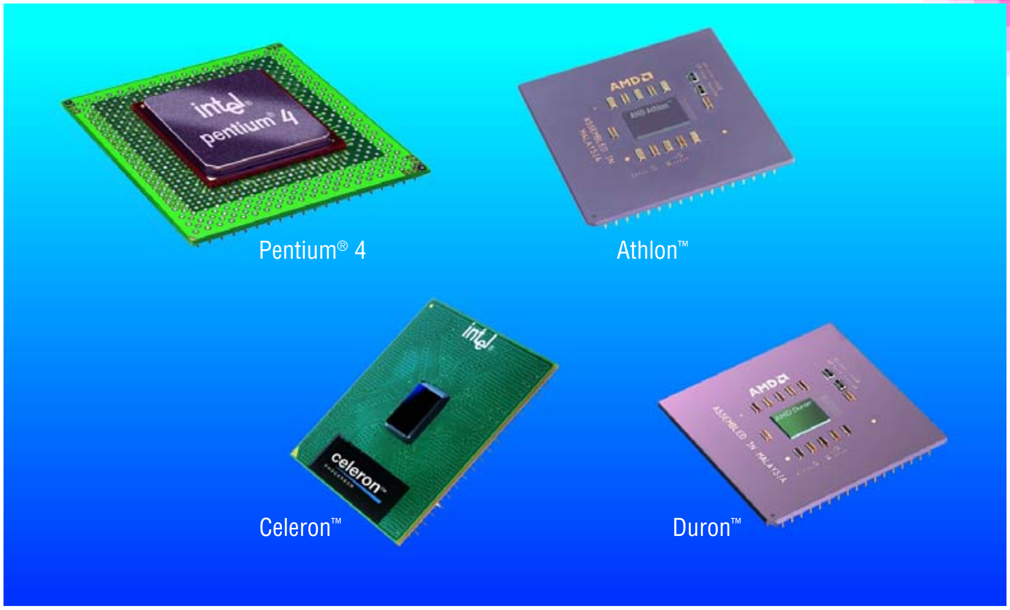


Figure 4-9 Most high-performance PCs use Pentium® and Athlon™ processors. Basic PCs have a Celeron™ or Duron™ processor.

COMPARISON OF WIDELY USED PERSONAL COMPUTER PROCESSORS

NAME	DATE INTRODUCED	MANUFACTURER	CLOCK SPEED	NUMBER OF TRANSISTORS
Pentium® 4	2000	Intel	1.4 GHz and up	42 million
Itanium™	2000	Intel	800 MHz and up	25.4-60 million
Pentium® III Xeon™	1999	Intel	500 MHz - 1 GHz	9.5-28 million
Pentium® III	1999	Intel	400 MHz - 1.2 GHz	9.5-28 million
Athlon™	1999	AMD	500 MHz - 1.2 GHz	22-37 million
Duron™	1999	AMD	600 - 800 MHz	18 million
AMD-K6® III	1999	AMD	400 - 450 MHz	21.3 million
Celeron™	1998	Intel	266 - 800 MHz	7.5-19 million
Pentium® II Xeon	1998	Intel	400 - 450 MHz	7.5-27 million
AMD-K6® II	1998	AMD	366 - 550 MHz	9.3 million
AMD-K6®	1998	AMD	300 MHz	8.8 million
Pentium® II	1997	Intel	234 - 450 MHz	7.5 million
Pentium® with MMX™ technology	1997	Intel	166 - 233 MHz	4.5 million
Pentium® Pro	1995	Intel	150 - 200 MHz	5.5 million
Pentium®	1993	Intel	75 - 200 MHz	3.3 million
80486DX	1989	Intel	25 - 100 MHz	1.2 million
80386DX	1985	Intel	16 - 33 MHz	275,000
80286	1982	Intel	6 - 12 MHz	134,000
PowerPC	1994	Motorola	50 - 500 MHz	Up to 50 million
68040	1989	Motorola	25 - 40 MHz	1.2 million
68030	1987	Motorola	16 - 50 MHz	270,000
68020	1984	Motorola	16 - 33 MHz	190,000
Alpha	1993	Digital; Compaq	150 - 700 MHz	Up to 100 million

Figure 4-10 A comparison of some of the more widely used personal computer processors.

Intel is a leading manufacturer of personal computer processors. With their earlier processors, Intel used a model number to identify the various chips. After learning that processor model numbers could not be trademarked and protected from use by competitors, Intel began identifying their processors with names — thus emerged their series of processors known as the Pentium®. Most high-performance PCs use a **Pentium®** processor. Less expensive, basic PCs use a brand of Intel processor called the **Celeron™**. Two more brands, called the **Xeon™** and **Itanium™** processors, are ideal for workstations and low-end servers.

Other companies such as AMD also make **Intel-compatible processors**. These processors have the same internal design or architecture as Intel processors and perform the same functions, but often are less expensive. Intel and Intel-compatible processors are used in PCs.

Apple Macintosh and Power Macintosh systems use a **Motorola processor**, which has a design different from the Intel-style processor. For Apple's PowerPC, Motorola introduced a new processor architecture that increased the speed of the computer.

The **Alpha processor**, which originally was developed by Digital Equipment Corporation, is used primarily in workstations and high-end servers. Current models of the Alpha chip run at clock speeds up to 700 MHz.

COMPANY ON THE CUTTING EDGE

intel®

Chips Dominate Computer Market

Answer: This company's chips power 85 percent of all desktop computers. Question: What is Intel?

Jeopardy television series contestants faced this question in 1994, and today Intel still is the world's largest chip maker. The company also is a major producer of boards, systems, and software for the personal computer, network, and communications industries.

When Gordon Moore and Robert Noyce started Intel in 1968, their goal was to build semiconductor memory to replace magnetic core memory. Intel refined the process of placing thousands of tiny electronic devices on a silicon chip; in 1970, Intel successfully introduced the 1103. One year later, this product became the world's best-selling semiconductor device. In 1971 Intel developed the 4004, the world's first processor.

This innovative spirit and attention to detail remain part of Intel's corporate culture. The company has grown to more than 70,000 employees in more than 40 countries. Intel supports the values of responding to customer needs, working with discipline and quality, taking risks, working in an open and satisfying environment, and striving for optimum results.

For more information on Intel, visit the Discovering Computers 2002 Companies Web page (**scsite.com/dc2002/companies.htm**) and click Intel.

COMPANY ON THE CUTTING EDGE

AMD

Intel-Compatible Processor Leader

In the 18th century, philosophers spoke of The Age of Enlightenment. In 1969, The Fifth Dimension sang of The Age of Aquarius. But could today be The Age of Asparagus? In the early 1980s, Advanced Micro Devices (AMD) adopted the phrase to characterize its commitment to develop increasing numbers of proprietary products for the computer industry. Executives identified this goal with asparagus farming because the crop grows slowly, but it is very lucrative once it takes hold.

The company's seeds sprouted and grew into the world's second-largest manufacturer of processors for Microsoft Windows-compatible personal computers. Along with the AMD-K6® and Athlon™ processors with 3DNow!™ technology, AMD also develops flash memory, programmable logic, communications, and networking devices. One-half of the company's nearly $3 billion in revenues is generated from sales outside the United States.

Co-founders Jerry Sanders and John Carey laid the foundation for AMD in Carey's living room in 1968. From the beginning, AMD guaranteed its microchips for every customer would meet or exceed stringent standards. More than three decades later, the company continues this commitment to "parametric superiority."

For more information on AMD, visit the Discovering Computers 2002 Companies Web page (**scsite.com/dc2002/companies.htm**) and click AMD.

A new type of personal computer processor, called an **integrated CPU**, combines functions of a processor, memory, and a video card on a single chip. Lower-costing personal computers and Internet appliances such as a set-top box sometimes use an integrated CPU.

Determining which processor is right for you will depend on how you plan to use the computer. If you purchase a PC (IBM-compatible), you will choose an Intel processor or an Intel-compatible processor. Apple Macintosh and Power Macintosh users will choose a PowerPC processor.

Your intended use also will determine the clock speed of the processor you choose. Processor speed is an important consideration. A home user surfing the Web, for example, will not need as fast a processor as an artist working with graphics or applications requiring multimedia capabilities such as full-motion video. Figure 4-11 describes guidelines for selecting an Intel processor. Remember, the higher the clock speed, the faster the processor — but also the more expensive the computer.

Today's processors use **MMX**™ (**multimedia extensions**) technology, which is a set of instructions built into the processor that allows it to manipulate and process multimedia data more efficiently. In addition to MMX, Intel's latest processors include **SSE instructions** (**streaming single-instruction, multiple-data instructions**), and AMD's latest processors have **3DNow!**™ technology. These two technologies further improve the processor's performance of multimedia, the Web, and 3-D graphics.

Processor Installation and Upgrades

Instead of buying an entirely new computer, you might be able to upgrade your processor to increase the computer's performance. Processor upgrades are one of three forms: chip for chip, piggyback, or daughterboard. With a **chip for chip upgrade**, you replace the existing processor chip with a new one. With a **piggyback upgrade**, you stack the new processor chip on top of the old one. With a **daughterboard upgrade**, the new processor chip is on a daughterboard. A **daughterboard** is a small circuit board that plugs into the motherboard, often to add additional capabilities to the motherboard.

INTEL PROCESSOR	DESIRED CLOCK SPEED	USE
Itanium™ or Xeon™	1 GHz and up	Power users with workstations; low-end servers on a network
Pentium® family	1 GHz and up	Power users or users that design professional drawings, produce and edit videos, record and edit music, participate in videoconference calls, create professional Web sites, play graphic-intensive multiplayer Internet games
	800 MHz - 1 GHz	Users that design professional documents containing graphics such as newsletters or number intensive spreadsheets; produce multimedia presentations; use the Web as an intensive research tool; edit photographs; send documents and graphics via the Web; watch videos; play graphic-intensive games on CD or DVD; create personal Web sites
	600 - 800 MHz	Home users that manage personal finances; create basic documents with word processing and spreadsheet software; communicate with others on the Web via e-mail, chat rooms, and discussions; shop on the Web; create basic Web pages
Celeron™	600 MHz and up	Home users that manage personal finances; create basic documents with word processing and spreadsheet software; edit photographs; make greeting cards and calendars; use educational or entertainment CD-ROMs; communicate with others on the Web via e-mail, chat rooms, and discussions

Figure 4-11 Determining which processor to obtain when you purchase a computer depends on your computer usage.

APPLY IT!

The Upgrade Dilemma

If you purchased your computer more than two years ago, then you probably have started to wonder if it is time to buy a new one. You might want one with a few additional options, such as a DVD drive, and a lot more power, especially because today's applications demand speed. The question is should you purchase a new computer or upgrade your current computer. The following list should help with your decision.

- If the processor is a 486 or older, donate it and purchase a new computer.
- If you have a computer with a slow processor, then consider the following upgrade options:
  - If the motherboard will accept a faster processor, replace it.
  - If the motherboard will not accept a faster processor, then consider an upgrade kit. The advantage of buying an upgrade kit is that memory and the processor are pre-installed on the motherboard.
  - Purchase a motherboard and processor of your choice. This option is for the more technical people who know the strengths and weaknesses of the various motherboards and which one will go well with the processor they are purchasing. Also, keep in mind that replacing the motherboard, even using an upgrade kit, is time-consuming.
- Additional items to consider are other devices that may need to be upgraded on your system. Some possibilities include more memory, a new monitor, more video RAM, USB ports, more hard disk storage, new or faster CD-ROM drive, and other storage devices such as a Zip® drive.

For more information on upgrading versus purchasing a new computer, visit the Discovering Computers 2002 Apply It Web page (**scsite.com/dc2002/apply.htm**) and click Chapter 4 Apply It #2.

A processor chip is inserted into an opening, or **socket**, on the motherboard. Many PGA (pin grid array) chips use a zero-insertion force socket. A **zero-insertion force (ZIF) socket** has a small lever or screw that facilitates the installation and removal of processor chips (Figure 4-12). Users easily can upgrade the processor on computers with a ZIF socket because this type of socket requires no force to remove and install a chip. Some motherboards have a second ZIF socket that holds an upgrade chip. In this case, the existing processor chip remains on the motherboard, and you install the upgrade chip into the second ZIF socket.

Heat Sinks and Heat Pipes

Newer processor chips generate a lot of heat, which could cause the chip to burn up. Often, the computer's main fan generates enough airflow to cool the processor. Sometimes, however, the processor requires a heat sink — especially when upgrading to a more powerful processor. A **heat sink** is a small ceramic or metal component with fins on its surface that absorbs and ventilates heat produced by electrical components. Some heat sinks are packaged as part of the processor chip. Others are installed on top or the side of the chip. Because a heat sink consumes a lot of room, a smaller device called a **heat pipe** cools processors in notebook computers.

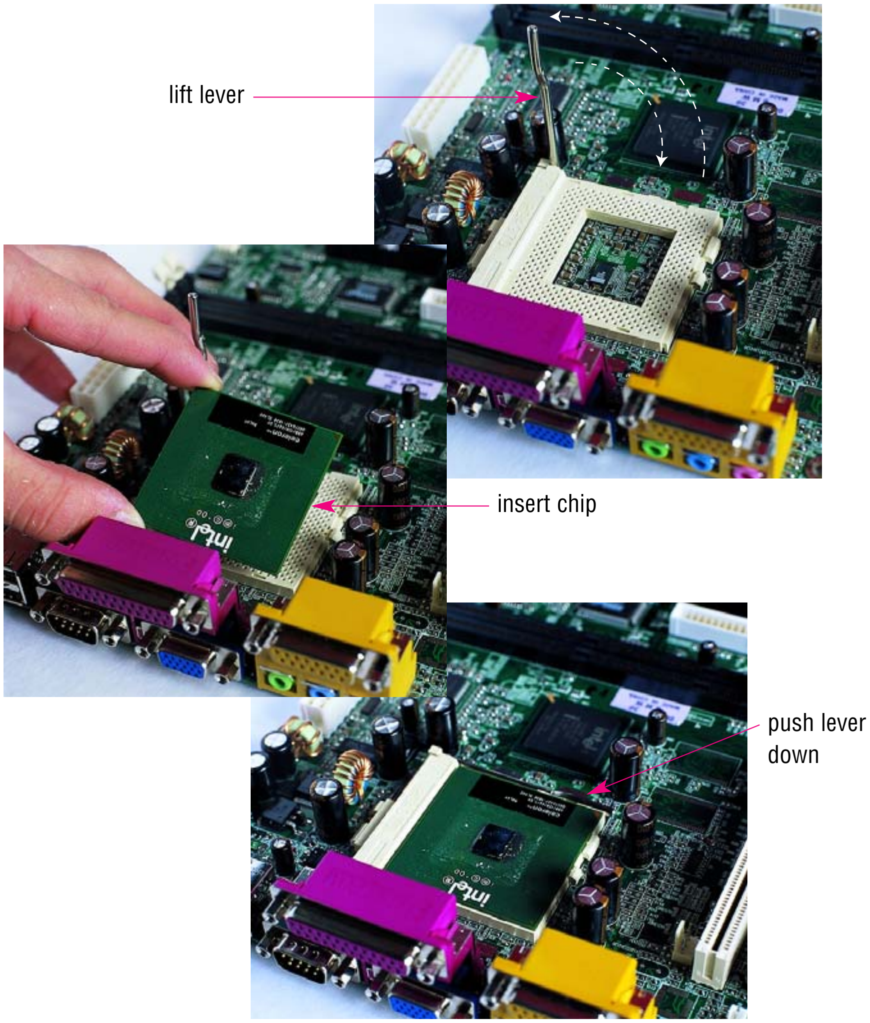


Figure 4-12 A zero-insertion force socket makes it easy to remove and re-install processor chips.

Coprocessors

Another way to increase the performance of a computer is through the use of a coprocessor. A **coprocessor** is a special processor chip or circuit board that assists the processor in performing specific tasks. Users running engineering, scientific, or graphics applications, for instance, will notice a dramatic increase in speed in applications that take advantage of a **floating-point coprocessor**. Floating-point coprocessors sometimes are called math or numeric coprocessors. Most of today's computers include a floating-point coprocessor.

Parallel Processing

Some computers use more than one processor to speed processing times. Known as **parallel processing**, this method uses multiple processors simultaneously to execute a program (Figure 4-13). Parallel processing divides up a problem so that multiple processors work on their assigned portion of the problem at the same time. As you might expect, parallel processing requires special software that recognizes how to divide up the problem and then bring the results back together again. Supercomputers use parallel processing for applications such as weather forecasting.

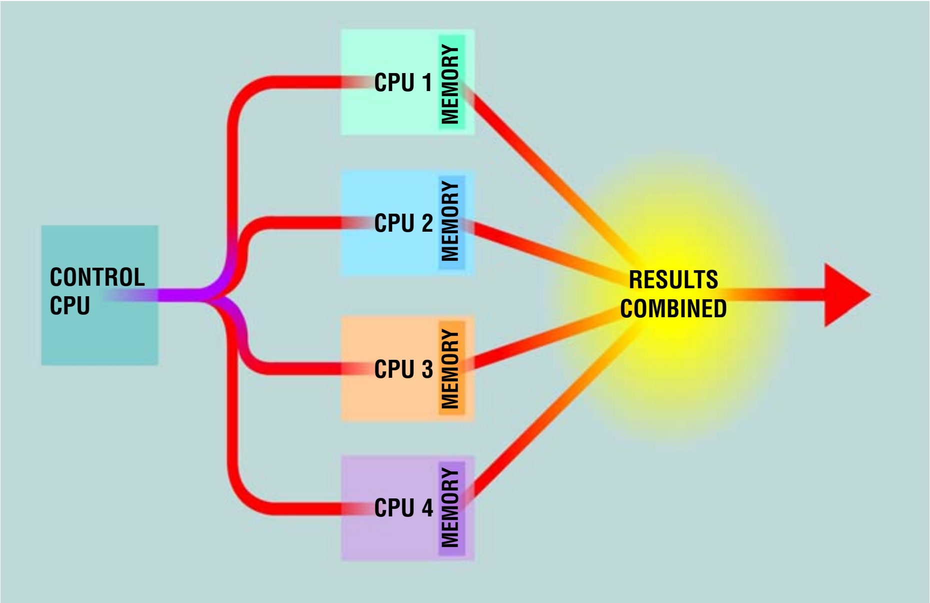


Figure 4-13 Parallel processing divides up a problem so that multiple processors work on their assigned portion of a problem at the same time.

DATA REPRESENTATION

To understand fully the way a computer processes data, it is important to know how a computer represents data. People communicate through speech by combining words into sentences. Human speech is **analog** because it uses continuous signals that vary in strength and quality. Most computers are **digital**. They recognize only two discrete states: on and off. This is because computers are electronic devices powered by electricity, which also has only two states: on or off.

Web Link

For more information on processors, visit the Discovering Computers 2002 Chapter 4 WEB LINK page (**scsite.com/dc2002/ch4/weblink.htm**) and click Processors.

TECHNOLOGY TRAILBLAZER

ANDY **GROVE**

Psychologists classify paranoia as a serious mental disorder; Intel Chairman Andy Grove classifies it as an essential component of business success. In Grove's book, *Only the Paranoid Survive*, he states that successful corporate managers constantly need to be on the lookout for competitors' threats. He personally worries about flawed products, unproductive factories, and low employee morale.

He advises college students to make career choices based on a variety of factors, including their strengths and weaknesses, their responsibilities at a particular company, to whom they would report, and their ability to adapt to new environments. He explains that after graduating from the University of California at Berkeley in 1963, he chose to work at Fairchild Semiconductor because he desired the California location and he wanted to work with Gordon Moore.

Five years later, he helped found Intel Corporation and was named president in 1979. From 1987 to 1998 he served as chief executive officer. He was named *Time* magazine's Man of the Year in 1997 for his innovative work on microchips, entrepreneurial spirit, and sharp, brilliant mind.

For more information on Andy Grove, visit the Discovering Computers 2002 People Web page (**scsite.com/dc2002/people.htm**) and click Andy Grove.

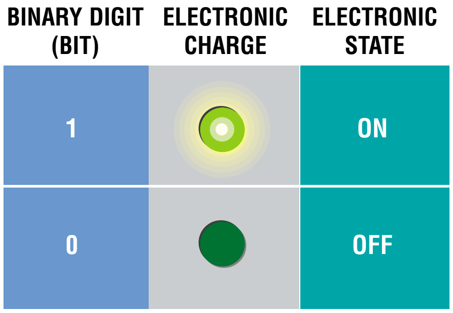
The two digits, zero and one, easily can represent these two states (Figure 4-14). The digit zero (0) represents the electronic state of off (absence of an electronic charge). The digit one (1) represents the electronic state of on (presence of an electronic charge).

When people count, they use the digits in the decimal system (0 through 9). The computer uses a binary system because it only understands two states. The **binary system** is a number system that has just two unique digits, 0 and 1, called bits. A **bit** (short for **bi**nary digi**t**) is the smallest unit of data the computer can represent. By itself, a bit is not very informative.

When eight bits are grouped together as a unit, they form a **byte**. A byte is informative because it provides enough different combinations of 0s and 1s to represent 256 individual characters. These characters include numbers, uppercase and lowercase letters of the alphabet, punctuation marks, and others such as the letters of the Greek alphabet.

The combinations of 0s and 1s that represent characters are defined by patterns called a coding scheme. In one coding scheme, the number 3 is represented as 00110011, the number 5 as 00110101, and the capital letter T as 01010100 (Figure 4-15). Two popular coding schemes are ASCII and EBCDIC (Figure 4-16). The **American Standard Code for Information Interchange**, or **ASCII** (pronounced ASK-ee), is the most widely used coding system to represent data. Most personal computers and mid-range servers use the ASCII coding scheme. The **Extended Binary Coded Decimal Interchange Code**, or **EBCDIC** (pronounced EB-see-dic) is used primarily on mainframe computers.

The ASCII and EBCDIC coding schemes are sufficient for English and Western European languages but are not large enough for Asian and other languages that use different alphabets. **Unicode** is a coding scheme capable of representing all the world's current languages. The appendix of this book discusses the ASCII, EBCDIC, and Unicode schemes in more depth, along with the parity bit and number systems.



BINARY DIGIT (BIT)	ELECTRONIC CHARGE	ELECTRONIC STATE
1	◉	ON
0	●	OFF

Figure 4-14 A computer circuit represents the 0 or the 1 electronically by the presence or absence of an electronic charge.

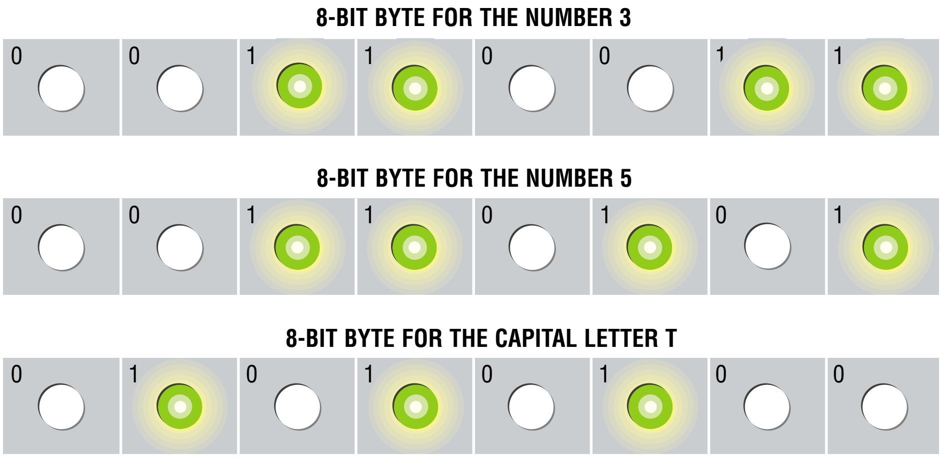

8-BIT BYTE FOR THE NUMBER 3
0 0 1 1 0 0 1 1
8-BIT BYTE FOR THE NUMBER 5
0 0 1 1 0 1 0 1
8-BIT BYTE FOR THE CAPITAL LETTER T
0 1 0 1 0 1 0 0

Figure 4-15 Eight bits grouped together as a unit are called a byte. A byte represents a single character in the computer.

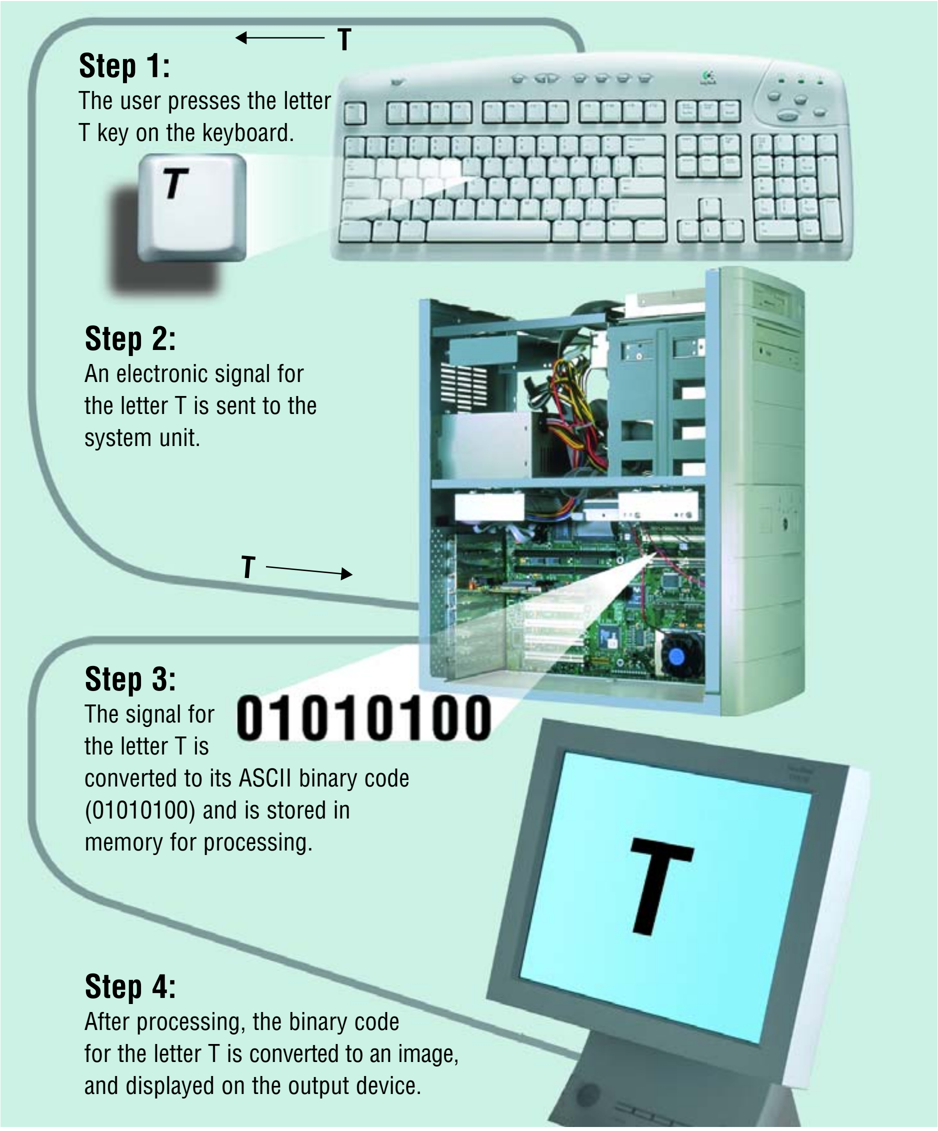
ASCII	SYMBOL	EBCDIC
00110000	0	11110000
00110001	1	11110001
00110010	2	11110010
00110011	3	11110011
00110100	4	11110100
00110101	5	11110101
00110110	6	11110110
00110111	7	11110111
00111000	8	11111000
00111001	9	11111001
01000001	A	11000001
01000010	B	11000010
01000011	C	11000011
01000100	D	11000100
01000101	E	11000101
01000110	F	11000110
01000111	G	11000111
01001000	H	11001000
01001001	I	11001001
01001010	J	11010001
01001011	K	11010010
01001100	L	11010011
01001101	M	11010100
01001110	N	11010101
01001111	O	11010110
01010000	P	11010111
01010001	Q	11011000
01010010	R	11011001
01010011	S	11100010
01010100	T	11100011
01010101	U	11100100
01010110	V	11100101
01010111	W	11100110
01011000	X	11100111
01011001	Y	11101000
01011010	Z	11101001
00100001	!	01011010
00100010	"	01111111
00100011	#	01111011
00100100	$	01011011
00100101	%	01101100
00100110	&	01010000
00101000	(	01001101
00101001	)	01011101
00101010	*	01011100
00101011	+	01001110

Figure 4-16 Two popular coding schemes are ASCII and EBCDIC.

Coding schemes such as ASCII make it possible for humans to interact with a digital computer that recognizes only bits. When you press a key on a keyboard, the electronic signal is converted into a binary form the computer recognizes and is stored in memory. Every character is converted to its corresponding byte. The computer then processes the data as bytes, which actually is a series of on/off electrical states. When processing is finished, software converts the bytes back into numbers, letters of the alphabet, or special characters so they can display on a screen or be printed (Figure 4-17). All of these conversions take place so quickly that you do not realize they are occurring.

Standards, such as those defined by ASCII and EBCDIC, make it possible for components within computers to communicate with each other successfully. These and other standards allow various manufacturers to produce a component and be assured that it will operate correctly in a computer – as long as it meets the defined standard. Standards also enable consumers to purchase components that are compatible with their computer configuration.

Figure 4-17 HOW A LETTER IS CONVERTED TO BINARY FORM AND BACK



Step 1:
The user presses the letter T key on the keyboard.

Step 2:
An electronic signal for the letter T is sent to the system unit.

Step 3:
The signal for the letter T is converted to its ASCII binary code (01010100) and is stored in memory for processing.

Step 4:
After processing, the binary code for the letter T is converted to an image, and displayed on the output device.

MEMORY

During processing, the processor places instructions to be executed and data needed by those instructions into memory. This **memory** is a temporary storage place for data, instructions, and information. Sometimes called primary storage, this and other types of memory consist of one or more chips on the motherboard or some other circuit board in the computer.

TECHNOLOGY TRAILBLAZER

GORDON **MOORE**

A $15 million watch would be extravagant for most people, but not for Gordon Moore, Intel's chairman emeritus. Although he no longer wears his timepiece, it serves as a reminder of Intel's venture into manufacturing and selling digital watches with liquid crystal displays for approximately $150 — until competitors started selling theirs for less than one-tenth the cost. Intel stopped making the watches in 1978.

As a co-founder of Intel in 1968, he witnessed a geometric growth in technology so consistent he could set his watch by it. When writing an article for *Electronics* magazine in 1965 to predict the growth of component technology for the next 10 years, he graphed data about memory chip performance. He predicted the number of transistors and resistors placed on computer chips would double every year, with a proportional increase in computing power and decrease in cost. This principle, Moore's Law, held true until 1975, when he changed the prediction to doubling every two years.

For more information on Gordon Moore, visit the Discovering Computers 2002 People Web page (**scsite.com/dc2002/people.htm**) and click Gordon Moore.

Memory stores three basic items: (1) the operating system and other system software that control the usage of the computer equipment; (2) application programs that carry out a specific task such as word processing; and (3) the data being processed by the application programs. This role of memory to store both data and programs is known as the **stored program concept**.

A byte (character) is the basic storage unit in memory. When application program instructions and data transfer into memory from storage devices, the instructions and data exist as bytes. Each byte resides temporarily in a location in memory, called an **address**. An address is simply a unique number that identifies the location of the byte in memory. The illustration in Figure 4-18 shows how seats in an airplane are similar to addresses in memory: (1) a seat holds one person at a time and an address in memory holds a single byte, (2) both a seat and an address can be empty, and (3) a seat has a unique identifying number and so does a memory address. To access data or instructions in memory, the computer references the addresses that contain bytes of data.

Figure 4-18 This figure shows how seats in an airplane are similar to addresses in memory: (1) a seat holds one person at a time and an address in memory holds a single byte, (2) both a seat and an address can be empty, and (3) a seat has a unique identifying number and so does a memory address.

Manufacturers state memory and storage sizes in terms of the number of bytes the device has available for storage (Figure 4-19). A **kilobyte** of memory, abbreviated **KB** or **K**, is equal to exactly 1,024 bytes. To make memory and storage definitions easier to identify, computer users often round a kilobyte down to 1,000 bytes. For example, if a memory chip can store 100 KB, it can hold approximately 100,000 bytes (characters). A **megabyte** (**MB**) is equal to approximately one million bytes. A **gigabyte** (**GB**) equals approximately one billion bytes.

The system unit contains two types of memory: volatile and nonvolatile. When the computer's power is turned off, **volatile memory** loses its contents. **Nonvolatile memory** (**NVM**), by contrast, does not lose its contents when power is removed from the computer. The following sections discuss various types of volatile and nonvolatile memory.

RAM

When users discuss memory in a computer, they usually are referring to RAM. **RAM** (**random access memory**) consists of memory chips that can be read from and written to by the processor and other devices. When the computer is powered on, certain operating system files (such as the files that determine how your Windows desktop displays) load from a storage device such as a hard disk into RAM. These files remain in RAM as long as the computer is running. As additional programs and data are requested, they also load from storage into RAM.

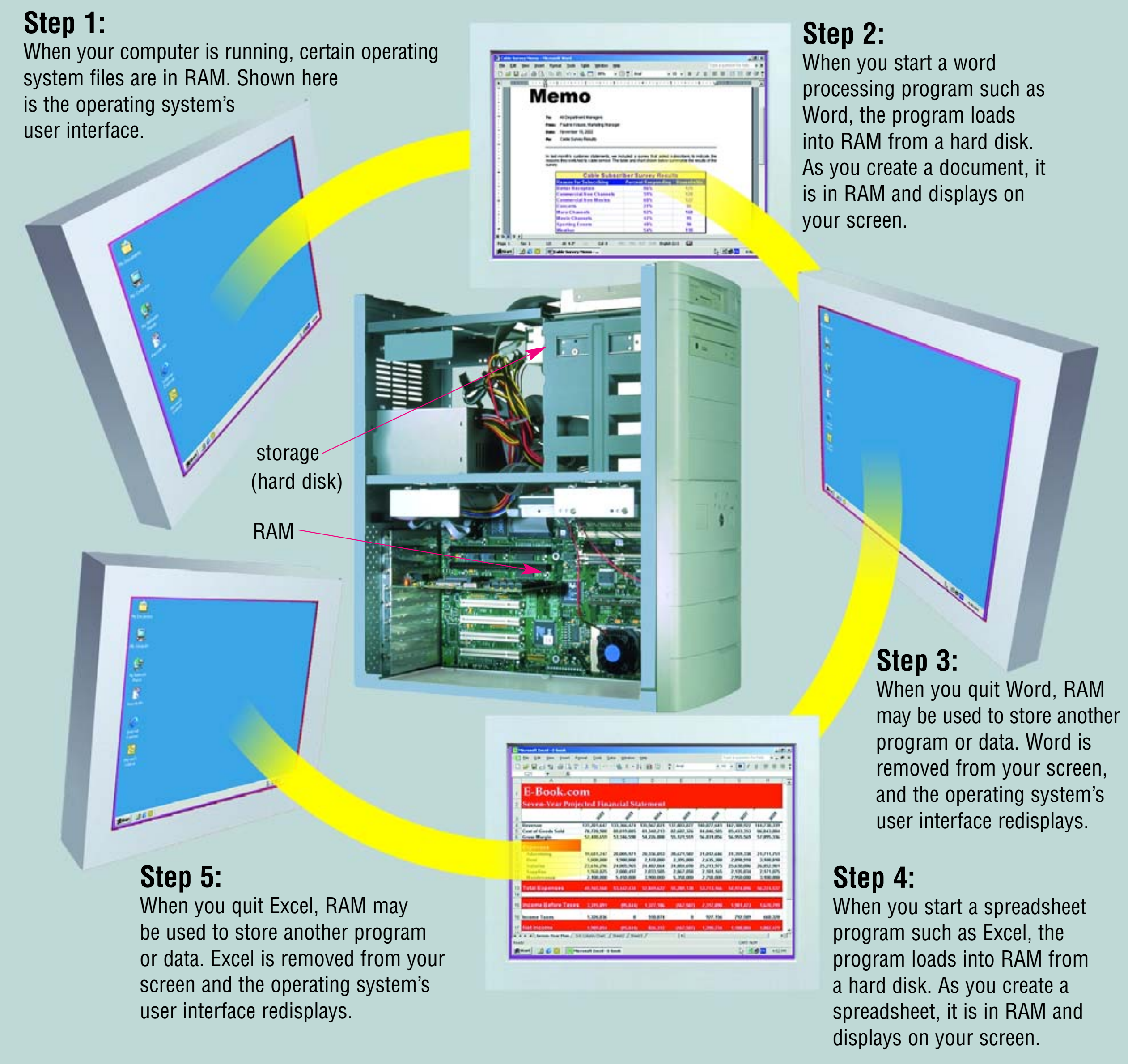
The processor interprets the data while it is in RAM. During this time, the contents of RAM may change (Figure 4-20). RAM can hold multiple programs simultaneously, provided the computer has enough RAM to accommodate all the programs. The program with which you are working usually displays on the screen.

MEMORY AND STORAGE SIZES

Term	Abbreviation	Approximate Memory Size	Exact Memory Amount	Approximate Number of Pages of Text
Kilobyte	KB or K	1 thousand bytes	1,024 bytes	1/2
Megabyte	MB	1 million bytes	1,048,576 bytes	500
Gigabyte	GB	1 billion bytes	1,073,741,824 bytes	500,000
Terabyte	TB	1 trillion bytes	1,099,511,627,776 bytes	500,000,000

Figure 4-19 This table outlines terms used to define memory and storage sizes.

Figure 4-20 HOW APPLICATION PROGRAMS TRANSFER IN AND OUT OF RAM



Step 1:
When your computer is running, certain operating system files are in RAM. Shown here is the operating system's user interface.

Step 2:
When you start a word processing program such as Word, the program loads into RAM from a hard disk. As you create a document, it is in RAM and displays on your screen.

Step 3:
When you quit Word, RAM may be used to store another program or data. Word is removed from your screen, and the operating system's user interface redisplays.

Step 4:
When you start a spreadsheet program such as Excel, the program loads into RAM from a hard disk. As you create a spreadsheet, it is in RAM and displays on your screen.

Step 5:
When you quit Excel, RAM may be used to store another program or data. Excel is removed from your screen and the operating system's user interface redisplays.

Most RAM is volatile. It loses its contents when the power is removed from the computer. For this reason, you must save any items you may need in the future. **Saving** is the process of copying items from RAM to a storage device such as a hard disk.

Two basic types of RAM chips exist: dynamic RAM chips and static RAM chips. Sometimes called **main memory**, dynamic RAM chips are the most common type of RAM. **Dynamic RAM**, or **DRAM** (pronounced DEE-ram), chips must be re-energized constantly or they lose their contents. Many variations of DRAM chips exist, most of which are faster than the basic DRAM. **Synchronous DRAM** (**SDRAM**) chips are much faster than DRAM chips because they are synchronized to the system clock. **Double data rate SDRAM** (**DDR SDRAM**) chips, also called **SDRAM II** chips, are faster than SDRAM chips because they transfer data twice for each clock cycle, instead of just once. **Direct Rambus® DRAM** (**Direct RDRAM®**) chips are yet another type of DRAM chips that are much faster than SDRAM chips because they use pipelining techniques. Most computers today use some form of SDRAM chips or RDRAM chips.

Static RAM chips, also called **SRAM** (pronounced ESS-ram) chips, are faster and more reliable than any variation of DRAM chips. These chips do not have to be re-energized as often as DRAM chips; thus, the term static is used. SRAM chips, however, are much more expensive than DRAM chips. Special applications such as cache use SRAM chips. A later section in this chapter discusses cache.

RAM chips often are smaller in size than processor chips. RAM chips usually reside on a small circuit board, called a **memory module**, which inserts into the motherboard (Figure 4-21). Three types of memory modules are SIMMs, DIMMs, and RIMMs.

With a **single inline memory module** (**SIMM**), the pins on opposite sides of the circuit board connect together to form a single set of contacts. With a **dual inline memory module** (**DIMM**), the pins on opposite sides of the circuit board do not connect and thus form two sets of contacts. SIMMs and DIMMs typically use SDRAM chips. A **Rambus® inline memory module** (**RIMM**) houses RDRAM chips.

RAM REQUIREMENTS The amount of RAM a computer requires often depends on the types of applications you plan to use on the computer. A computer only can manipulate data that is in memory. RAM is similar to the workspace on the top of your desk. Just as a desktop needs a certain amount of space to hold papers, pens, a stapler, your telephone, and so on, a computer needs a certain amount of memory to store application programs and files. The more RAM a computer has, the more programs and files it can work on at once.

A software package usually indicates the minimum amount of RAM it requires (Figure 4-22). If you want the application to perform optimally, you usually need more than

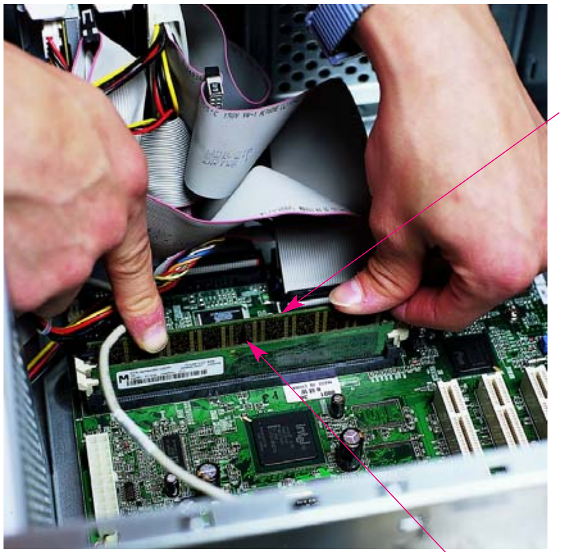
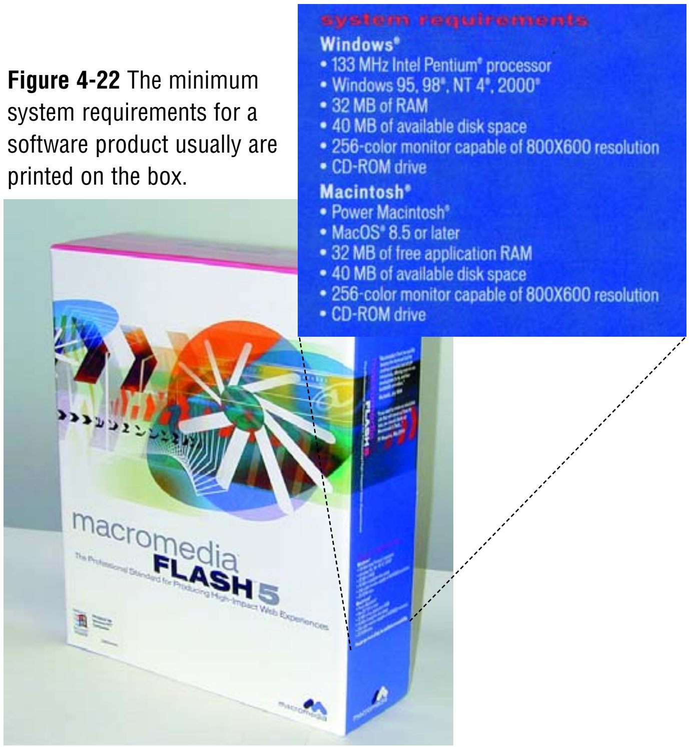


Figure 4-21 This photo shows a dual inline memory module (DIMM).

Figure 4-22 The minimum system requirements for a software product usually are printed on the box.



system requirements

Windows®
- 133 MHz Intel Pentium® processor
- Windows 95, 98®, NT 4®, 2000®
- 32 MB of RAM
- 40 MB of available disk space
- 256-color monitor capable of 800X600 resolution
- CD-ROM drive

Macintosh®
- Power Macintosh®
- MacOS® 8.5 or later
- 32 MB of free application RAM
- 40 MB of available disk space
- 256-color monitor capable of 800X600 resolution
- CD-ROM drive

macromedia
FLASH 5
The Professional Standard for Producing High-Impact Web Experiences

the minimum specifications on the software package.

Generally, home users running Windows and using standard application software such as word processing should have at least 32 MB of RAM. Most business users that work with accounting, financial, or spreadsheet programs, voice recognition, and programs requiring multimedia capabilities should have a minimum of 64 MB of RAM. Users composing multimedia presentations or using graphics-intensive applications will want at least 256 MB of RAM.

Figure 4-23a provides guidelines for the amount of RAM for various types of users. Figure 4-23b shows advertisements that match to each user requirement. Advertisements normally list the type of processor, the clock speed of the processor in MHz or GHz, and the amount of RAM in the computer. The amount of RAM in computers purchased today ranges from 64 MB to 512 MB.

The amount of RAM on the computer determines the amount of programs and data a computer can handle at one time, which affects overall performance. The more RAM, the faster the computer will respond.

Cache

Most of today's computers improve processing times with cache (pronounced cash). Two types of **cache** are memory cache and disk cache. This chapter discusses memory cache. Chapter 7 discusses disk cache.

Memory cache, also called a **cache store** or **RAM cache**, helps speed the processes of the computer because it stores frequently used instructions and data. The processor is likely to request these items repeatedly, so the items are stored for quick access. When the processor needs an instruction or data, it first searches cache. If it cannot locate the item in cache, then it searches RAM.

Most modern computers have two or three types, or layers, of memory cache: Level 1, Level 2, and Level 3. **Level 1 (L1) cache**, also called **primary cache** or **internal cache**, is built directly into the processor chip. L1 cache usually has a very small capacity, ranging from 8 KB to 64 KB. The most common size is 16 KB.

When discussing cache, most users are referring to L2 cache. **Level 2 (L2) cache**, or **external cache**, is slightly slower than L1 cache but has a much larger capacity, ranging from 64 KB to 4 MB. On older computers, L2 cache was not part of the processor chip. Instead, it

Web Link

For more information on cache, visit the Discovering Computers 2002 Chapter 4 WEB LINK page (**scsite.com/dc2002/ch4/weblink.htm**) and click Cache.

Figure 4-23a (RAM guidelines)

RAM (in MB)	**64 to 128 MB** (minimum)	**128 to 256 MB** (minimum)	**256 MB and up**
Use	Home and business users managing personal finances, using standard application software such as word processing; using educational or entertainment CD-ROMs; communicating with others on the Web	Users requiring more advanced multimedia capabilites; running number-intensive accounting, financial, or spreadsheet programs; using voice recognition; working with videos, music, and digital imaging; creating Web sites; participating in video-conferences; playing Internet games	Power users creating professional Web sites; running sophisticated CAD, 3-D design, or other graphics-intensive software

Figure 4-23b (computers for sale)

Model	C600Z	A750Q	A866M	P933G	P1.5R	A1.20
Processor	600 MHz Celeron™ processor	750 MHz Duron™ processor	866 MHz Athlon™ processor	933 MHz Pentium® 4 processor	1.5 GHz Pentium® 4 processor	1.2 GHz Athlon™ processor
Memory	64 MB SDRAM Memory	128 MB SDRAM Memory	128 MB SDRAM Memory	256 MB SDRAM Memory	256 MB SDRAM Memory	384 MB SDRAM Memory

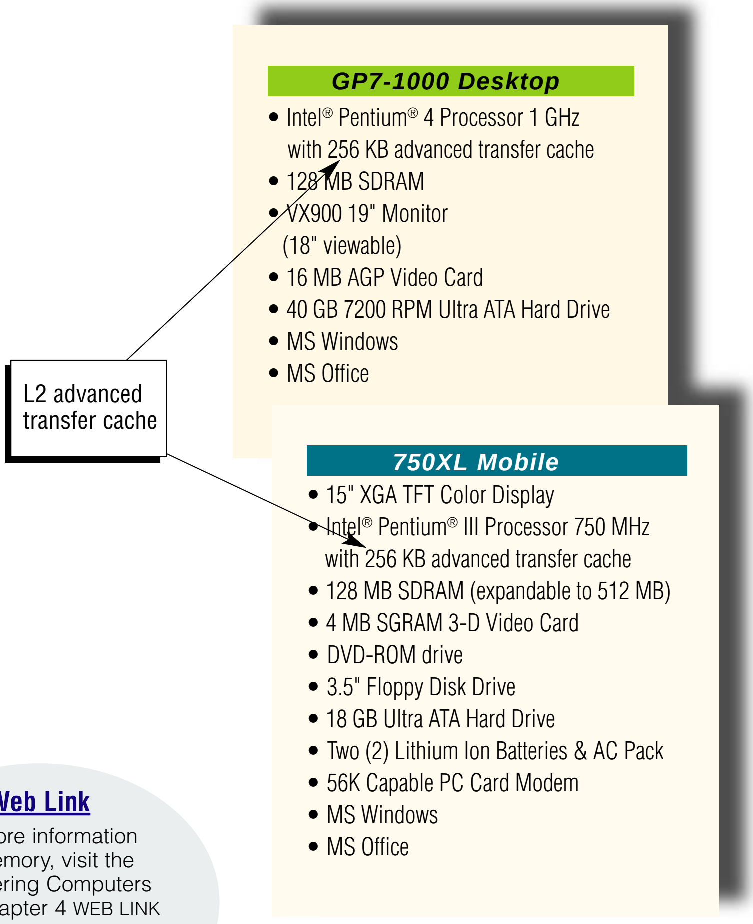
Figure 4-23 Determining how much RAM you need depends on the applications you intend to run on your computer. Advertisements for computers normally list the type of processor, the speed of the computer measured in MHz or GHz, as well as the amount of RAM installed.

consisted of high-speed SRAM chips on the motherboard or a separate card of chips inserted into a slot in the computer. Current processors include **advanced transfer cache**, a type of L2 cache built directly on the processor chip. Processors that use advanced transfer cache perform at much faster rates than those that do not use it. The common size of advanced transfer cache is 256 KB.

If a processor has L2 advanced transfer cache, it also can use L3 cache. **L3 cache** is a cache separate from the processor chips on the motherboard. L3 cache only exists on computers that use L2 advanced transfer cache.

Cache speeds up processing time because it stores frequently used instructions and data. When the processor needs an instruction or data, it searches memory in this order: L1 cache, then L2 cache, then L3 cache (if it exists), then RAM — with a greater delay in processing for each level of memory it must search. If the instruction or data is not found in memory, then it must search a slower speed storage device such as a hard disk or CD-ROM.

A computer with L2 cache usually performs at speeds 10- to 40-percent faster than those without cache. To realize the largest increase in performance, a desktop computer should have at least 256 KB of L2 advanced transfer cache (Figure 4-24). Servers and workstations have at least 2 MB of L2 advanced transfer cache.


L2 advanced transfer cache

GP7-1000 Desktop

- Intel® Pentium® 4 Processor 1 GHz with 256 KB advanced transfer cache
- 128 MB SDRAM
- VX900 19" Monitor (18" viewable)
- 16 MB AGP Video Card
- 40 GB 7200 RPM Ultra ATA Hard Drive
- MS Windows
- MS Office

750XL Mobile

- 15" XGA TFT Color Display
- Intel® Pentium® III Processor 750 MHz with 256 KB advanced transfer cache
- 128 MB SDRAM (expandable to 512 MB)
- 4 MB SGRAM 3-D Video Card
- DVD-ROM drive
- 3.5" Floppy Disk Drive
- 18 GB Ultra ATA Hard Drive
- Two (2) Lithium Ion Batteries & AC Pack
- 56K Capable PC Card Modem
- MS Windows
- MS Office

Figure 4-24 As shown in these advertisements, most current systems are equipped with at least 256 KB of L2 advanced transfer cache.

Web Link

For more information on memory, visit the Discovering Computers 2002 Chapter 4 WEB LINK page (**scsite.com/dc2002/ch4/weblink.htm**) and click Memory.

ROM

Read-only memory (**ROM** pronounced rahm) refers to memory chips storing data that only can be read. The data on ROM chips cannot be modified — hence, the name read only. ROM is nonvolatile. Its contents are not lost when power is removed from the computer.

ROM chips contain data, instructions, or information that is recorded permanently. For example, ROM contains the **basic input/output system** (**BIOS** pronounced BYE-ohss), which is a sequence of instructions the computer follows to load the operating system and other files when you first turn on the computer. Many other devices also contain ROM chips. For example, ROM chips in many printers contain data for fonts.

Manufacturers of ROM chips often record the data, instructions, or information on the chips when they manufacture the chip. These ROM chips, called **firmware,** contain permanently written data, instructions, or information. The BIOS is firmware that contains the computer's startup instructions.

A variation of the ROM chip, called a **programmable read-only memory** (**PROM**) chip, is a blank ROM chip on which you can place items permanently. Programmers use **microcode** instructions to program a PROM chip. Once a programmer writes the microcode onto the PROM chip, it functions like a regular ROM chip and cannot be erased or changed.

A programmer can erase microcode on a type of PROM chip, called an **EEPROM** (**electrically erasable programmable read-only memory**). Flash memory, discussed in the next section, uses a variation of EEPROM.

Flash Memory

Flash memory, also known as **flash ROM** or **flash RAM**, is a type of nonvolatile memory that can be erased electronically and reprogrammed. Many current computers use flash BIOS. With **flash BIOS**, the computer easily can update the contents of the BIOS chip, if necessary.

Flash memory chips store data and programs on many handheld computers and devices, such as digital cellular telephones, printers, set-top boxes, digital cameras, automotive devices, digital voice recorders, and pagers (Figure 4-25). **Flash memory cards** store flash memory on a removable device instead of a chip. Removable flash memory allows users to transfer data and information conveniently from these small devices to their desktop computers. A later section in this chapter discusses these cards in more depth. Flash memory is available in sizes up to 128 MB.

CMOS

Another type of memory chip in the system unit is complementary metal-oxide semiconductor memory. **Complementary metal-oxide semiconductor memory**, abbreviated **CMOS** (pronounced SEE-moss), stores configuration information about the computer. This information includes the type of disk drives, keyboard, and monitor; the current date and time; and other startup information needed when you turn on the computer.

CMOS chips use battery power to retain information even when the power to the computer is off. Battery-backed CMOS memory thus keeps the calendar, date, and time current even when the computer is off. Unlike standard ROM, the computer can change information in CMOS, such as when you change from standard time to daylight savings time or when you add new hardware devices to the computer.

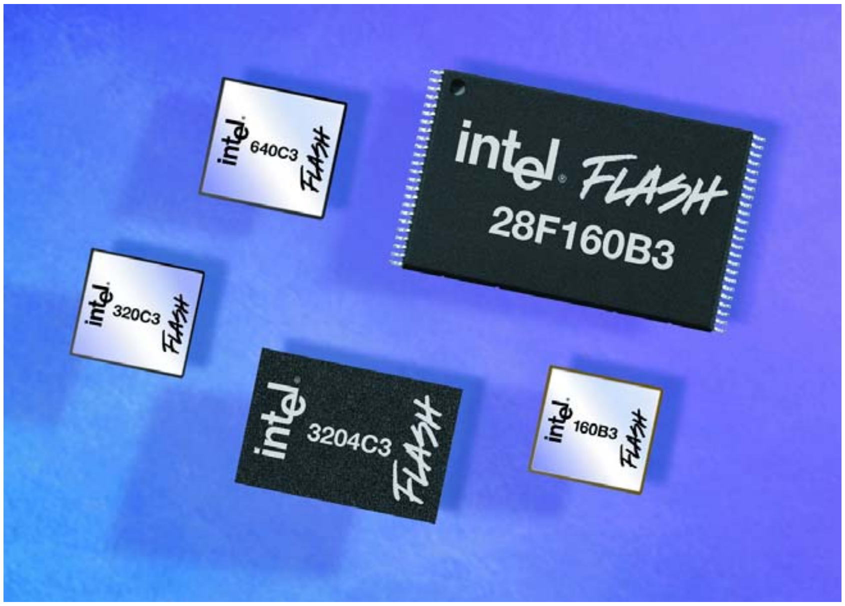


Figure 4-25 Flash memory chips are used in personal and handheld computers, digital cellular telephones, printers, set-top boxes, digital cameras, automotive devices, digital voice recorders, and pagers.

APPLY IT!

Your Computer's Battery

Is your computer clock losing time? If so, that is a warning that your CMOS battery is about to go. Moreover, when it does, you will have a difficult time accessing your computer until you change the battery. The CMOS battery powers both the computer's internal clock and a CMOS memory chip that holds all the computer's crucial setup information, such as hard disk parameters, types of floppy drives, and memory size. The battery is easy to replace. Just follow these steps:

1. Obtain a replacement battery from a local vendor or online computer parts dealer.
2. Record your computer's setup information. You can do this by booting your computer and entering its setup mode. Write down all of the settings from the various menus. Alternatively, you can use a software program, such as Norton Utilities, that stores a backup copy of your computer's CMOS settings on a floppy disk.
3. Turn off the computer.
4. Open the case and locate the battery on the motherboard. See your user manual for specifications about the battery and its location.
5. Remove the old battery and replace it with the new one. You may have to move some cables around.
6. Document the date you replaced the battery.
7. Replace the case and turn on the computer. An error message will display.
8. Enter your computer's setup mode.
9. Reenter the settings you recorded from the various setup menus. If you used a program such as Norton Utilities, restore the settings from the floppy disk.

Caution: Do not forget to observe proper anti-static precautions when working inside the case of your computer.

For more information on CMOS and replacing the battery, visit the Discovering Computers 2002 Apply It Web page (**scsite.com/dc2002/apply.htm**) and click Chapter 4 Apply It #3.

Memory Access Times

Access time is the amount of time it takes the processor to read data, instructions, and information from memory. A computer's access time directly affects how fast the computer processes data. Manufacturers use a variety of terminology to state access times (Figure 4-26). Some use fractions of a second, which for memory, occurs in nanoseconds. A **nanosecond** (abbreviated **ns**) is one billionth of a second. A nanosecond is extremely fast (Figure 4-27). In fact, electricity travels about one foot in a nanosecond.

Other manufacturers state access times in MHz, e.g., an 83 MHz SDRAM. If a manufacturer states access time in megahertz, you can convert it to nanoseconds by dividing the megahertz number into 1 billion ns. For example, 133 MHz equals approximately 7.5 ns.

The access time (speed) of memory contributes to the overall performance of the computer. SDRAM chips can have access times up to 133 MHz (7.5 ns). The faster RDRAM chips can have access times up to 800 MHz (1.25 ns). ROM's access times range from 25 to 250 ns. Accessing data in memory can be more than 200,000 times faster than accessing data on a hard disk.

While access times of memory greatly affect overall computer performance, manufacturers and retailers usually list a computer's memory in terms of its size, not its access time. Thus, an advertisement might describe a computer as having 32 MB of SDRAM expandable to 512 MB.

You can expand memory capacity in a number of ways, such as installing additional memory in an expansion slot or inserting a memory card into a card slot.

ISSUE

Chip Recall

Processor Chip Flaws

A glitch within a single computer chip can cause untold problems. In 1994, a design flaw in Intel's Pentium® chip caused a rounding error once in every nine billion division operations. For most users, this would result in a mistake only once in every 27,000 years, so Intel initially ignored the problem. After an unexpected public outcry, Intel supplied replacements to anyone who asked, which cost the company nearly $500 million. Did people overreact? Did the demand for perfection divert funds that could have been spent better elsewhere? (Intel's costs were equivalent to half a year's research and development budget.) How much perfection do consumers have a right to expect? How serious should a problem be before a chip is recalled?

For more information on processor chips and flaw issues, visit the Discovering Computers 2002 Issues Web page (**scsite.com/dc2002/issues.htm**) and click Chapter 4 Issue #2.

ACCESS TIME TERMINOLOGY

TERM	ABBREVIATION	SPEED
Millisecond	ms	One-thousandth of a second
Microsecond	μs	One-millionth of a second
Nanosecond	ns	One-billionth of a second
Picosecond	ps	One-trillionth of a second

Figure 4-26 Access times are measured in fractions of a second. This table outlines terms used to define access times.

10 million operations = 1 blink

Figure 4-27 It takes about one-tenth of a second to blink your eye, which is the equivalent of 100 million nanoseconds. A computer can perform some operations in as little as 10 nanoseconds. In the time it takes to blink your eye, a computer can perform some operations 10 million times.

Web Link

For more information on flash memory, visit the Discovering Computers 2002 Chapter 4 WEB LINK page (**scsite.com/dc2002/ch4/weblink.htm**) and click Flash Memory.

EXPANSION SLOTS AND EXPANSION CARDS

An **expansion slot** is an opening, or socket, where you can insert a circuit board into the motherboard. These circuit boards add new devices or capabilities to the computer such as more memory, higher-quality sound devices, a modem, or graphics capabilities (Figure 4-28). A variety of terms identify a circuit board that fits in an expansion slot: **card**, **expansion card**, **expansion board**, **board**, **adapter card**, **adapter**, **interface card**, **add-in**, and **add-on**.

Sometimes a device or feature is built into a card. With other cards, a cable connects the expansion card to a device, such as a scanner, outside the system unit. Figure 4-29 shows someone inserting an expansion card into an expansion slot on a personal computer motherboard.

Four types of expansion cards found in most of today's computers are a video card, a sound card, a network interface card, and a modem card. A **video card**, also called a **video adapter** or **graphics card**, converts computer output into a video signal that is sent through a cable to the monitor, which displays an image on the screen. A **sound card** enhances the sound-generating capabilities of a personal computer by allowing sound to be input through a microphone and output through speakers. A **network interface card** (**NIC** pronounced nick), also called a **network card**, is a communications device that allows the computer to communicate via a network. A **modem card**, also called an **internal modem**, is a communications device that enables computers to communicate via telephone lines or other means.

TYPES OF EXPANSION CARDS

EXPANSION CARD	PURPOSE
Accelerator	To increase the speed of the processor
Controller	To connect disk drives; being phased out because newer motherboards support these connections
Game	To connect a joystick
I/O	To connect input and output devices such as a printer or mouse; being phased out because newer motherboards support these connections
Interface	To connect other peripherals such as a mouse, CD-ROM, or scanner
Memory	To add more memory to the computer
Modem	To connect to other computers through telephone lines
Network Interface	To connect to other computers and peripherals
PC-to-TV converter	To connect to a television
Sound	To connect speakers or microphone
TV Tuner	To view television channels on your monitor
Video	To connect a monitor
Video Capture	To connect a camcorder

Figure 4-28 This table lists some of the types of expansion cards and their functions.

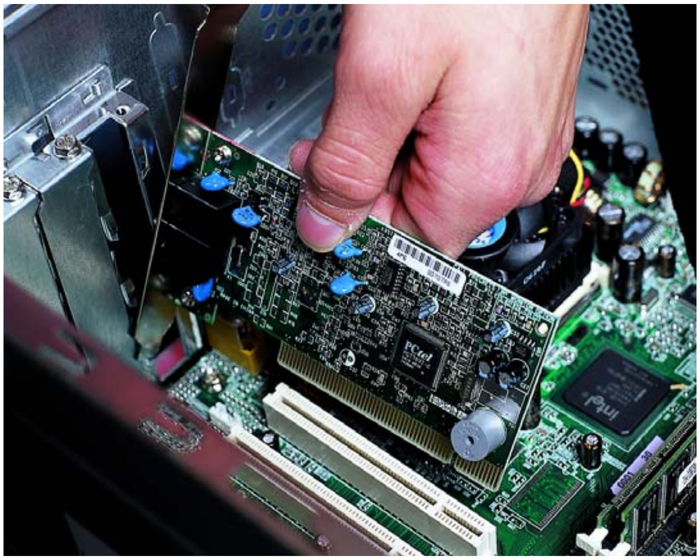


Figure 4-29 This figure shows an expansion card being inserted into an expansion slot on the motherboard of a personal computer.

Web Link

For more information on expansion cards, visit the Discovering Computers 2002 Chapter 4 WEB LINK page (**scsite.com/dc2002/ch4/weblink.htm**) and click Expansion Cards.

In the past installing a card was not easy and required you set switches and other elements on the motherboard. Many of today's computers support Plug and Play. With **Plug and Play**, the computer automatically can configure cards and other devices as you install them. Having Plug and Play support means you can plug in a device, turn on the computer, and then use, or *play*, the device without having to configure the computer manually.

PC Cards and Flash Memory Cards

Notebook and other mobile computers have a special type of expansion slot for installing PC Cards. A **PC Card** is a thin credit card-sized device that adds memory, disk drives, sound, fax/modem, communications, and other capabilities to a mobile computer such as a notebook computer (Figure 4-30). Because of their small size and versatility, many consumer electronics products such as digital cameras, cable TV, and automobiles use PC Cards.

All PC Cards conform to standards developed by the **P**ersonal **C**omputer **M**emory **C**ard **I**nternational **A**ssociation (these cards originally were called **PCMCIA cards**). This helps to ensure that you can interchange PC Cards among handheld computers. PC Cards are all the same length and width, and fit in a standard PC Card slot. A notebook computer usually has a PC card slot on one of its edges.

The three types of PC Cards are Type I, Type II, and Type III. The only difference in size among the three types is their thickness. The thinnest **Type I cards** add memory capabilities to the computer. **Type II cards** contain communications devices such as modems. The thickest **Type III cards** house devices such as hard disks.

Web Link

For more information on PC Cards, visit the Discovering Computers 2002 Chapter 4 WEB LINK page (**scsite.com/dc2002/ch4/weblink.htm**) and click PC Cards.

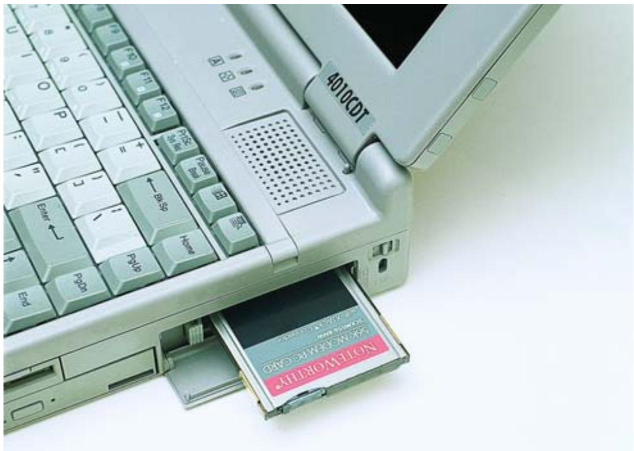


Figure 4-30 This picture shows a PC Card sticking out of a PC Card slot on a notebook computer.

ISSUE

Is Cheaper Just as Good?

Personal Computer Prices

Today, you can buy a personal computer for less than $1,000 that has as much functionality as one nearly twice its cost two years ago. These low prices allow consumers today to shop for computer bargains. Many consumers want inexpensive computers that are adequate for basic tasks, such as word processing and Internet access. They feel that spending higher prices on computers with faster processors and more hard disk space is an unnecessary, frivolous expense. As one industry analyst asks, "Why buy a Porsche when you are going to drive only 55 miles per hour?" How might a greater availability of lower costing personal computers change the way schools and businesses use them? Does a higher price mean better quality, with respect to computers? Is it necessary to have the latest and greatest technology in a personal computer?

For more information on prices of personal computers, visit the Discovering Computers 2002 Issues Web page (**scsite.com/dc2002/issues.htm**) and click Chapter 4 Issue #3.

Flash memory cards are available in a variety of sizes (Figure 4-31). Many handheld computers and devices, such as digital computers, digital music players, and cellular telephones, use these memory cards. Some printers and computers have built-in card readers or slots. You also can purchase an external card reader that attaches to any computer. The type of card you have will determine the type of card reader you need.

Unlike other cards that require you to open the system unit and install the card onto the motherboard, you can change a PC Card or flash memory card without having to open the system unit or restart the computer. For example, if you need to connect to the Internet, you can just insert the modem card in the PC Card slot of your notebook computer while the computer is running. The operating system automatically recognizes the new card and allows you to connect to the Internet.

This feature of PC Cards and flash memory cards, called **hot plugging** or **hot swapping**, allows you to add and remove devices while a computer is running.

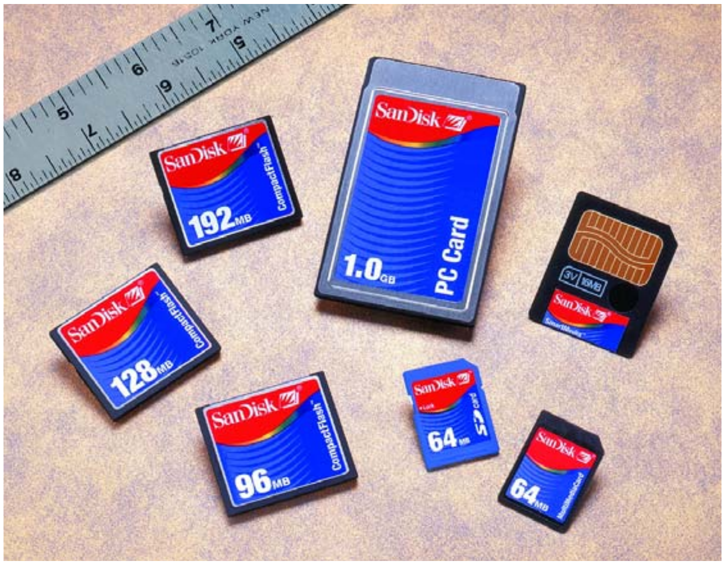


Figure 4-31 Flash memory cards are available in a wide range of sizes.

PORTS

External devices such as a keyboard, monitor, printer, mouse, and microphone, often attach by a cable to the system unit. A **port** is the interface, or point of attachment, to the system unit. The back of the system unit contains many ports (Figure 4-32).

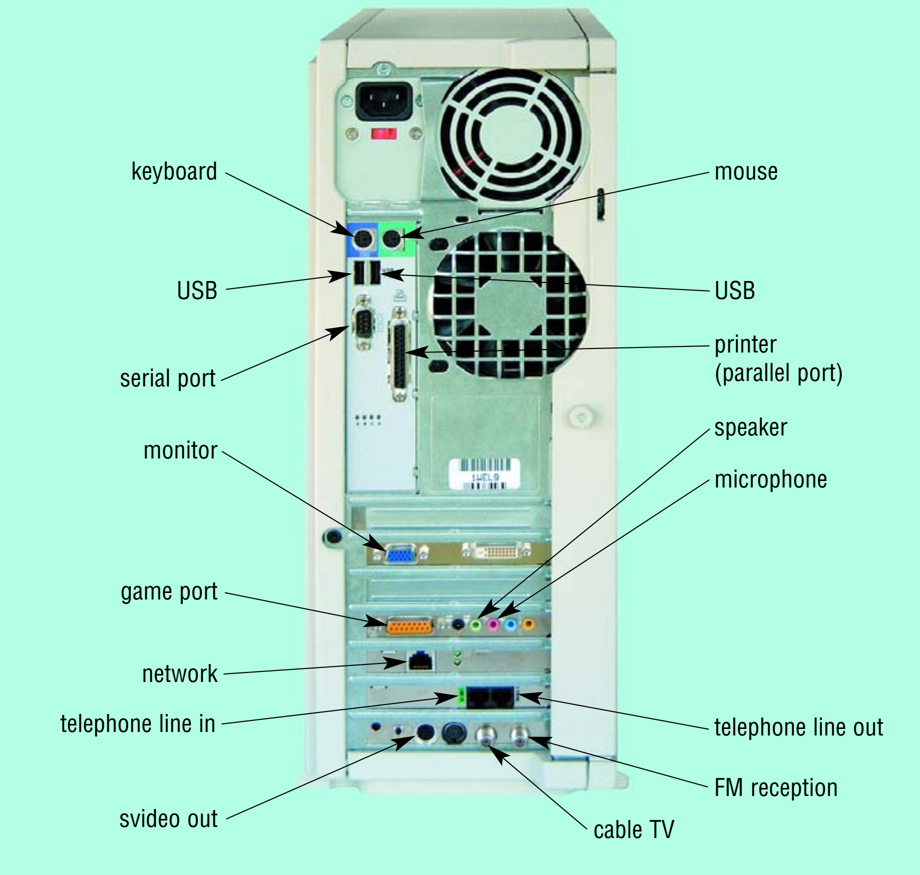


Figure 4-32 A port is an interface that allows you to connect a peripheral device such as a printer, mouse, or keyboard to the computer. The back of the system unit has many ports.

Web Link

For more information on ports and connectors, visit the Discovering Computers 2002 Chapter 4 WEB LINK page (**scsite.com/dc2002/ch4/weblink.htm**) and click Ports and Connectors.

Ports have different types of connectors. A **connector** joins a cable to a device (Figure 4-33).

One end of a cable attaches to the connector on the system unit and the other end of the cable attaches to a connector on the peripheral device. Most connectors are available in one of two genders: male or female. **Male connectors** have one or more exposed pins, like the end of an electrical cord you plug into the wall. **Female connectors** have matching holes to accept the pins on a male connector, like an electrical wall outlet.

Figure 4-34 shows the different types of connectors on a system unit. Some system units include these connectors when you buy the computer. You add other connectors by inserting cards into the computer. The card has a port that allows you to attach a device to the card.

When you purchase a cable to connect your computer to a peripheral, the manufacturers often identify the cables by their connector types. For example, a printer port might use any

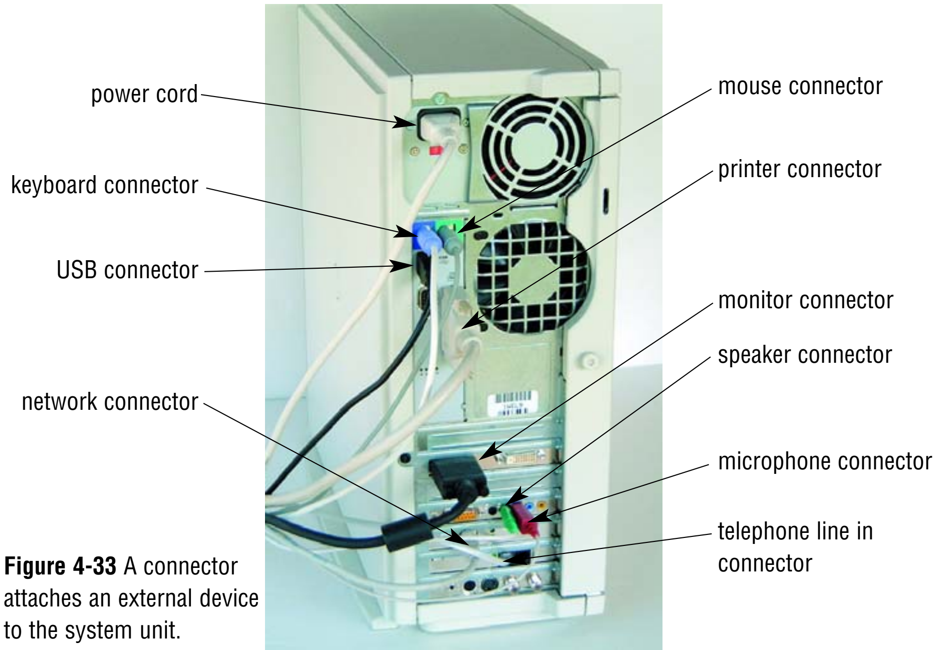
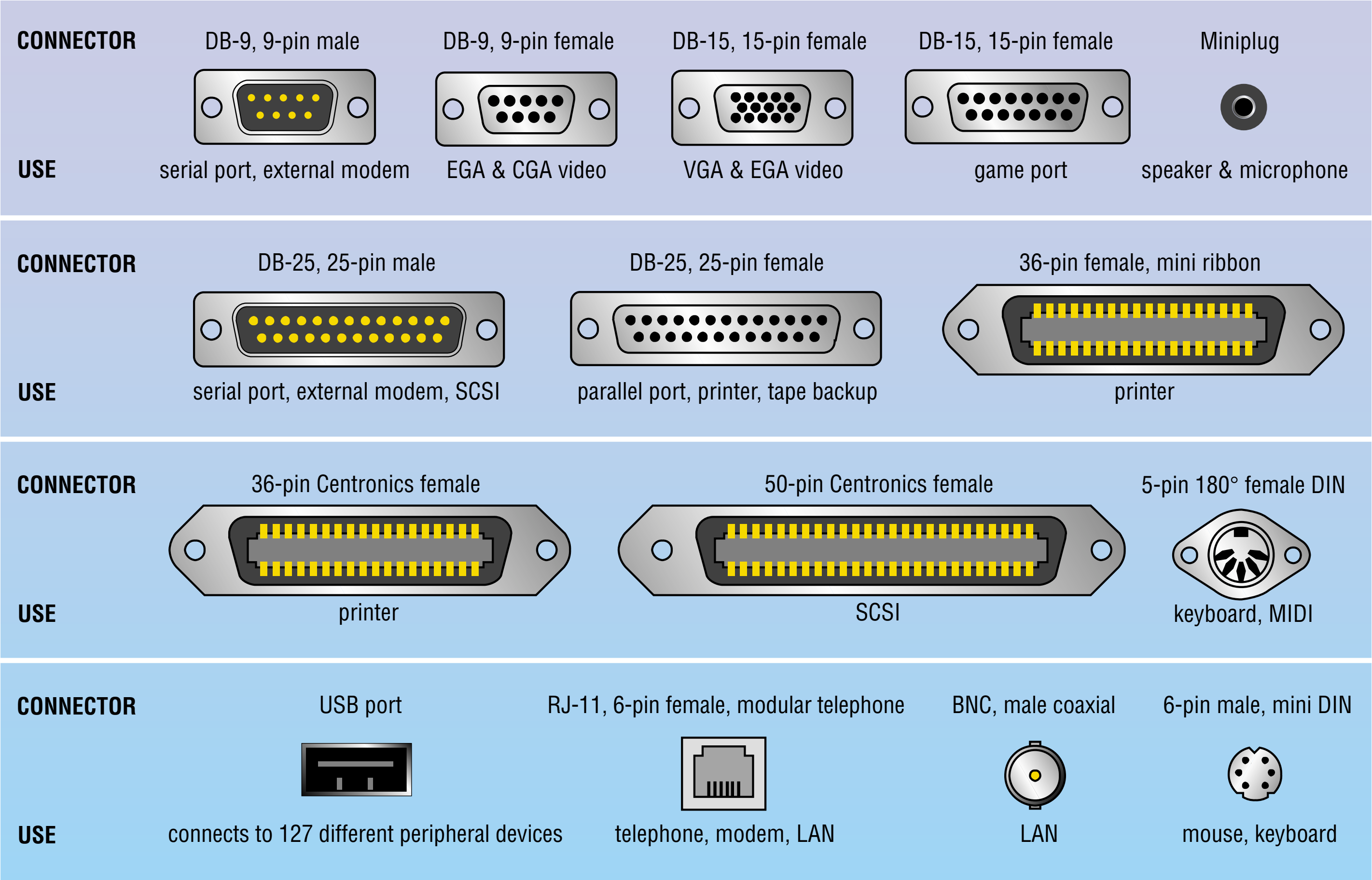


Figure 4-33 A connector attaches an external device to the system unit.



CONNECTOR	DB-9, 9-pin male	DB-9, 9-pin female	DB-15, 15-pin female	DB-15, 15-pin female	Miniplug
USE	serial port, external modem	EGA & CGA video	VGA & EGA video	game port	speaker & microphone

CONNECTOR	DB-25, 25-pin male	DB-25, 25-pin female	36-pin female, mini ribbon
USE	serial port, external modem, SCSI	parallel port, printer, tape backup	printer

CONNECTOR	36-pin Centronics female	50-pin Centronics female	5-pin 180° female DIN
USE	printer	SCSI	keyboard, MIDI

CONNECTOR	USB port	RJ-11, 6-pin female, modular telephone	BNC, male coaxial	6-pin male, mini DIN
USE	connects to 127 different peripheral devices	telephone, modem, LAN	LAN	mouse, keyboard

Figure 4-34 Examples of different types of connectors on a system unit.

one of these connectors: 25-pin female, 36-pin female, 36-pin Centronics female, or USB. Thus, you should understand the differences among connector types.

Sometimes you cannot attach a new peripheral device to the computer because the connector on the system unit is the same gender as the connector on the cable. You can use a gender changer to solve this problem. A **gender changer** is a device that enables you to join two connectors that are either both female or both male.

Most computers have three types of ports: serial, parallel, and USB. The next section discusses each of these ports.

Serial Ports

A **serial port** is one type of interface that connects a device to the system unit by transmitting data one bit at a time (Figure 4-35). Serial ports usually connect devices that do not require fast data transmission rates, such as a mouse, keyboard, or modem. The COM port on the system unit is one type of serial port.

Some modems that connect the system unit to a telephone line use a serial port because the telephone line expects the data in a specific frequency. Serial ports conform to either the RS-232 or RS-422 standard, which specifies the number of pins used on the port's connector. Two common connectors for serial ports are a male 25-pin connector and a male 9-pin connector.

Parallel Ports

Unlike a serial port, a **parallel port** is an interface that connects devices by transferring more than one bit at a time (Figure 4-36). Parallel ports originally were developed as an alternative to the slower speed serial ports.

Many printers connect to the system unit using a parallel port with a 25-pin female connector. This parallel port can transfer eight bits of data (one byte) simultaneously through eight separate lines in a single cable. A parallel port sometimes is

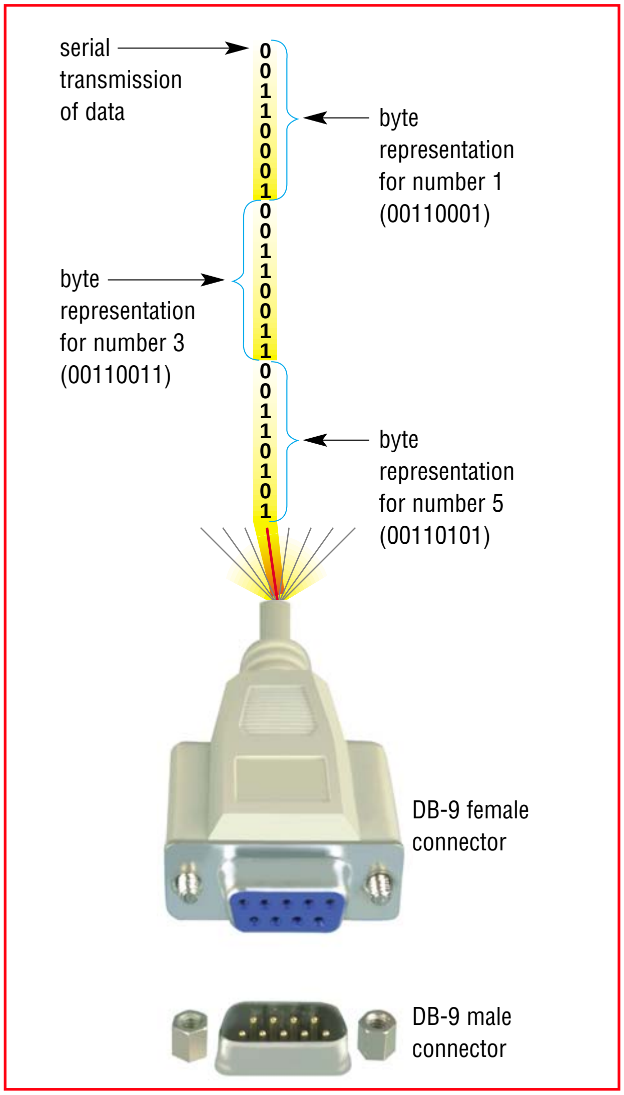

serial transmission of data
00110001
00110011
00110101
byte representation for number 1 (00110001)
byte representation for number 3 (00110011)
byte representation for number 5 (00110101)
DB-9 female connector
DB-9 male connector

Figure 4-35 A serial port transmits data one bit at a time. One wire sends data; another receives data; and the remaining wires are used for other communications operations.

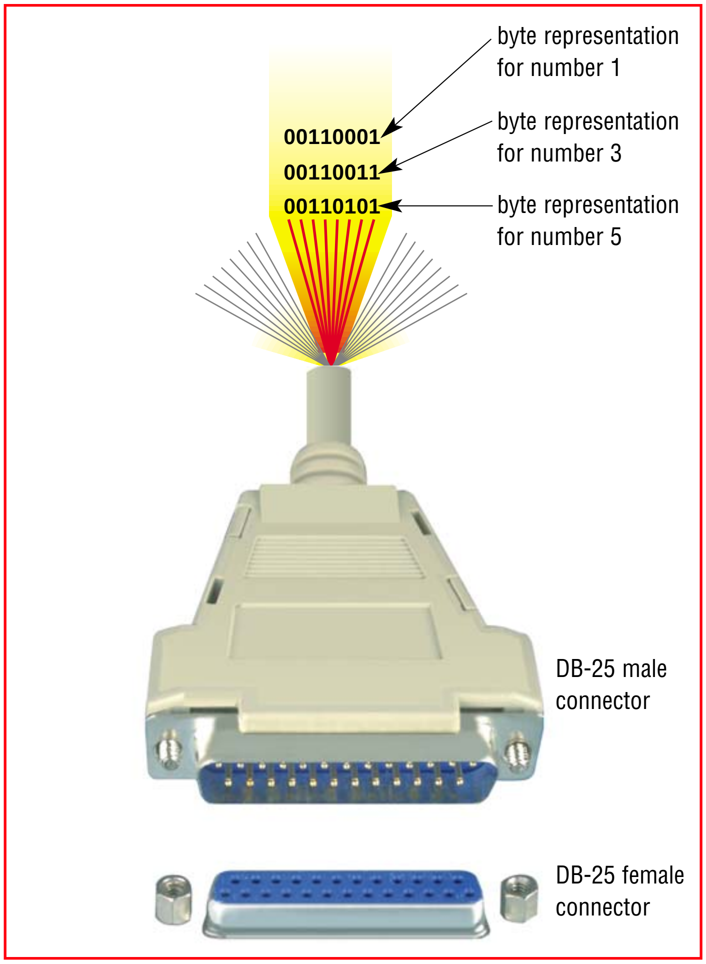

byte representation for number 1
00110001
byte representation for number 3
00110011
byte representation for number 5
00110101
DB-25 male connector
DB-25 female connector

Figure 4-36 A parallel port is capable of transmitting more than one bit at a time. The port shown in this figure has eight wires that transmit data; the remaining wires are used for other communications operations.

called a Centronics interface, after the company that first defined the standard for communications between the system unit and a printer.

Two newer types of parallel ports, the EPP (Enhanced Parallel Port) and the ECP (Extended Capabilities Port), use the same connectors as the Centronics port, but are more than 10 times faster. Both EPP and ECP are part of the IEEE (Institute of Electrical and Electronics Engineers) 1284 standard. The **IEEE 1284** standard specifies how older and newer peripheral devices that use a parallel port should transfer data to and from a computer.

Universal Serial Bus Port

A **universal serial bus** (**USB**) **port** can connect up to 127 different peripheral devices with a single connector type. Many system units have one or two USB ports (see Figure 4-32 on page 4.25). To attach multiple devices using a single port, you can daisy chain the devices together outside the system unit. That is, the first USB device connects to the USB port on the computer, the second USB device connects to the first USB device, the third USB device connects to the second USB device, and so on. An alternative to daisy chaining is to use a USB hub. A **USB hub** plugs into the USB port on the system unit and contains multiple USB ports into which you plug cables from USB devices.

Some newer peripheral devices may attach only to a USB port. Others attach to either a serial or parallel port, as well as a USB port. When connecting a device to a USB port, you do not need to install a card in the computer. Simply plug one end of the cable into the USB port and the other end into the device. Having a standard port and connector greatly simplifies the process of attaching devices to a personal computer.

The USB also supports hot plugging and Plug and Play, which means you can attach peripherals while the computer is running. With serial and parallel port connections, by contrast, you often must restart the computer after you attach the device.

Special-Purpose Ports

Four special-purpose ports used on many of today's computers are 1394, MIDI, SCSI, and IrDA. The following section discusses each of these ports.

1394 PORT Similarly to the USB port, the IEEE **1394 port**, also called **FireWire**, can connect multiple types of devices that require faster data transmission speeds such as digital video cameras, digital VCRs, color printers, scanners, digital cameras, and DVD drives to a single connector. You can connect up to 63 devices together using a 1394 port. The 1394 port also supports Plug and Play. The Macintosh G4 computer has a 1394 port.

Many computer professionals believe that ports such as USB and 1394 someday will replace serial and parallel ports completely (Figure 4-37).

MIDI PORT A special type of serial port, called a **musical instrument digital interface**, or **MIDI** (pronounced MID-dee) port, connects the system unit to a musical instrument, such as an electronic keyboard. The electronic music industry has adopted MIDI as a standard to define how devices, such as sound cards and synthesizers, represent sounds electronically. A **synthesizer**, which can be a peripheral or a chip, creates sound from digital instructions.

A system unit with a MIDI port has the capability of recording sounds that have been created by a synthesizer and then processing the sounds (the data) to create new sounds. Just about every sound card supports the MIDI standard, so you can play and manipulate sounds on a computer that were created originally on another computer.

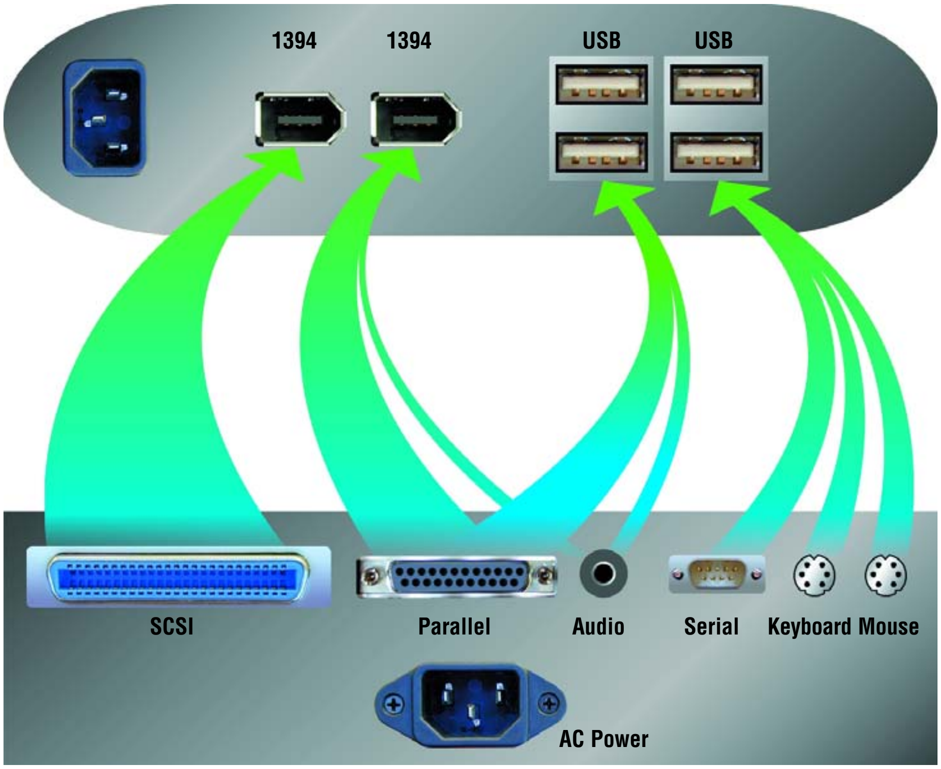


Figure 4-37 Many computer professionals believe that ports such as USB and 1394 someday will replace serial and parallel ports completely.

SCSI PORT A **small computer system interface** (**SCSI** pronounced skuzzy) port is a special high-speed parallel port that allows you to attach SCSI peripheral devices such as disk drives and printers. Depending on the type of SCSI interface, you can daisy chain either up to 7 or 15 devices together. That is, the first SCSI device connects to the computer, the second SCSI device connects to the first SCSI device, and so on. Some new computers include a SCSI port. Others have a slot that supports a SCSI card.

IrDA PORT Peripheral devices may not use any cables. Instead, some transmit data via infrared light waves. For these wireless devices to transmit signals to a computer, both the computer and the device must have an **IrDA port** (Figure 4-38). These ports conform to standards developed by the **IrDA** (**Infrared Data Association**).

Operating similar to a television remote control, you must align the IrDA port on the peripheral device with the IrDA port on the computer so that nothing obstructs the path of the infrared light wave. Devices that use IrDA ports include the keyboard, mouse, printer, digital cameras, digital telephones, and pagers. Several of these devices use a high-speed IrDA port, sometimes called a **FIR** (**fast infrared**) port.

BUSES

As previously explained, a computer processes and stores data as a series of electronic bits. These bits transfer internally within the circuitry of the computer along electrical channels. Each channel, called a **bus**, allows the various devices inside and attached to the system unit to communicate with each other. Just as vehicles travel on a highway to move from one destination to another, bits travel on a bus (Figure 4-39 on the next page).

Buses transfer bits from input devices to memory, from memory to the processor, from the processor to memory, and from memory to output or storage devices. Buses consist of two parts: a data bus and an address bus. The data bus transfers actual data and the address bus transfers information about where the data should go in memory.

The size of a bus, called the **bus width**, determines the number of bits that the computer can transmit at one time. For example, a 32-bit bus can transmit 32 bits (four bytes) at a time. On a 64-bit bus, bits transmit from one location to another 64 bits (eight bytes) at a time. The larger the number of bits handled by the bus, the faster the computer transfers data.

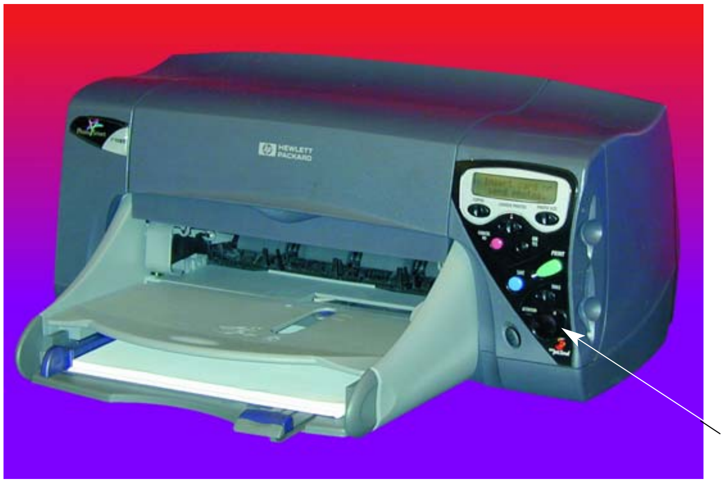


Figure 4-38 Some devices communicate wirelessly through an IrDA port.

Web Link

For more information on buses, visit the Discovering Computers 2002 Chapter 4 WEB LINK page (**scsite.com/dc2002/ch4/weblink.htm**) and click Buses.

ISSUE

High-Speed Ports

USB and 1394

In 1996, a few computer manufacturers started to include universal serial bus (USB) support in newer machines. With the release of the iMac in 1998 the USB became widespread. Many consider the USB to be the most important advance to date in connectivity standards for the personal computer. The primary selling point of USB is Plug and Play. Another selling point is that you can daisy chain up to 127 different peripheral devices. It is important to note that 127 is a theoretical limit. In reality, the number of devices is limited by their need for bandwidth and power needs. Another Plug and Play port that supports high speed data transfer rates is the IEEE 1394, also known as FireWire. A 1394 port can handle up to 63 daisy-chained devices. The primary difference between USB and 1394 is that 1394 is more expensive and supports faster data transfer rates. For those with the newest computers and the latest version of Windows 98, USB and 1394 devices should prove much easier to install and use than devices dependent on expansion cards. Will USB and 1394 eventually replace serial and parallel ports? Will consumers be willing to pay more for a 1394 port for faster transfer rates? Why or why not?

For more information on the USB and 1394 devices, visit the Discovering Computers 2002 Issues Web page (**scsite.com/dc2002/issues.htm**) and click Chapter 4 Issue #4.

Using the highway analogy again, assume that one lane on a highway can carry one bit. A 32-bit bus is like a 32-lane highway. A 64-bit bus is like a 64-lane highway.

If a number in memory occupies 8 bytes, or 64 bits, the computer must transmit it in two separate steps when using a 32-bit bus: once for the first 32 bits and once for the second 32 bits. Using a 64-bit bus, the computer can transmit the number in a single step, transferring all 64 bits at once. The wider the bus, the fewer number of transfer steps required and the faster the transfer of data. Figure 4-40 lists some personal computer processors and their bus widths.

In conjunction with the bus width, many computer professionals discuss a computer's word size. **Word size** is the number of bits the processor can interpret and execute at a given time. That is, a 64-bit processor can manipulate 64 bits at a time. Computers with a larger word size can process more data in the same amount of time than computers with a smaller word size. In most computers, the word size is the same as the bus width.

Every bus also has a clock speed. Just like the processor, manufacturers state the clock speed for a bus in megahertz. Recall that one megahertz (MHz) is equal to one million ticks per second. Most of today's processors have a bus speed of either 100 MHz or 133 MHz. The higher the bus clock speed, the faster the transmission of data, which results in applications running faster.

A computer has two basic types of buses: a system bus and an expansion bus. A **system bus** is part of the motherboard and connects the processor to main memory. An **expansion bus** allows the processor to communicate with peripheral devices. When computer professionals use the term bus by itself, they usually are referring to the system bus.

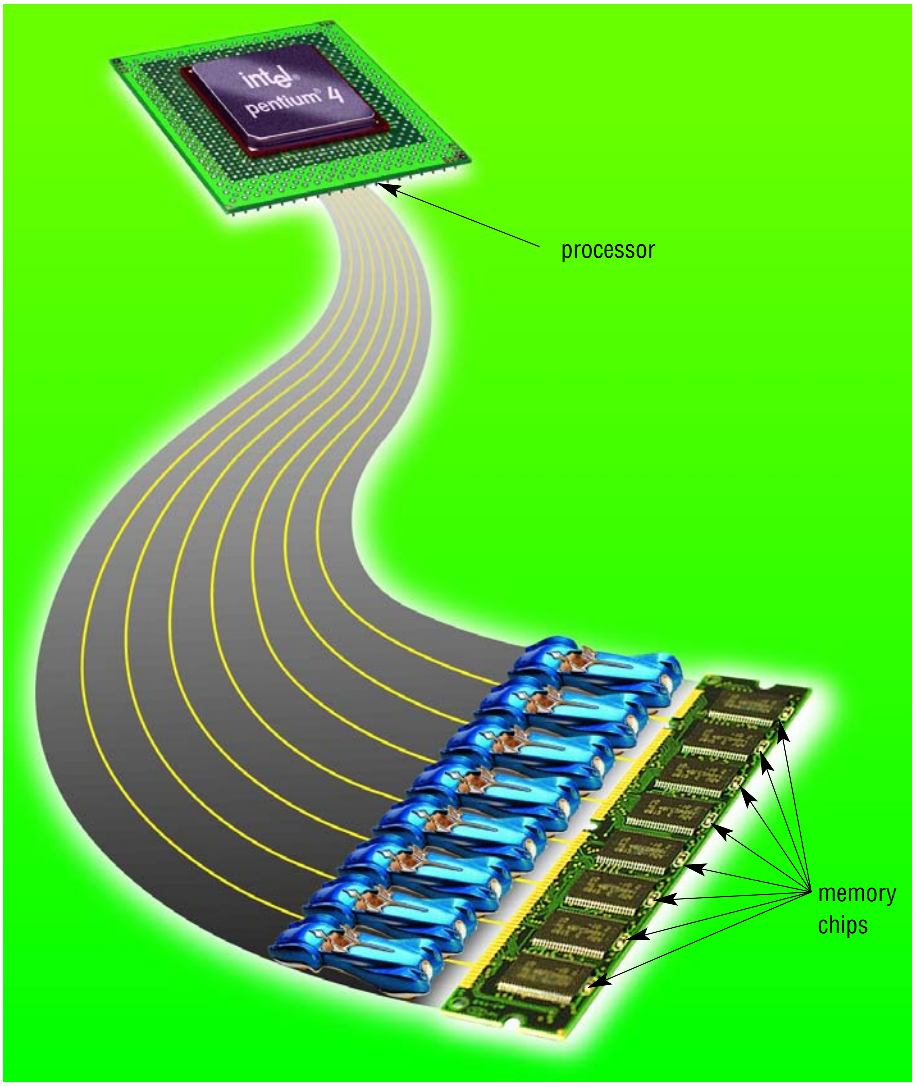


Figure 4-39 Just as vehicles travel on a highway to move from one destination to another, bits travel on a bus. Buses transfer bits from input devices to memory, from memory to the processor, from the processor to memory, and from memory to output or storage devices.

COMPARISON OF BUS WIDTHS

NAME	BUS WIDTH*
Pentium® 4	64
Itanium™	64
Pentium® III Xeon™	64
Pentium® III	64
Celeron™	64
Pentium® II Xeon™	64
Pentium® II	64
Pentium® with MMX™ technology	64
Pentium® Pro	64
Pentium®	64
80486DX	32
80386DX	32
80286	16
PowerPC	64
68040	32
68030	32
68020	32

Figure 4-40 A comparison of bus widths on some personal computer processors.

Expansion Bus

Some devices outside the system unit connect to a port on a card, which is inserted into an expansion slot. This expansion slot connects to the expansion bus, which allows the processor to communicate with the peripheral device attached to the card. Data transmitted to memory or the processor travels from the expansion bus via the expansion bus and the system bus (Figure 4-41).

The types of expansion buses on a motherboard determine the types of cards you can add to your computer. Thus, you should understand the following types of expansion buses: ISA bus, PCI bus, AGP bus, USB, 1394 bus, and PC Card bus.

- The most common and slowest expansion bus is the **ISA (Industry Standard Architecture) bus**. A mouse, modem card, sound card, and low-speed network interface card are examples of devices that connect to the ISA bus directly or through an ISA bus expansion slot.
- A **local bus** is a high-speed expansion bus that connects higher speed devices such as hard disks. The first standard local bus was the **VESA local bus**, which was used primarily for video cards. The current local bus standard is the **PCI (Peripheral Component Interconnect) bus** because it is more versatile than the VESA local bus. Types of cards you can insert into a PCI bus expansion slot include video cards, sound cards, SCSI cards, and high-speed network interface cards. The PCI bus transfers data about four times faster than the ISA bus. Most current personal computers have a PCI bus as well as an ISA bus.
- The **Accelerated Graphics Port (AGP)** is a bus designed by Intel to improve the speed with which 3-D graphics and video transmit. With an AGP video card in an AGP bus slot, the AGP bus provides a faster, dedicated interface between the video card and memory. Newer processors support AGP technology.

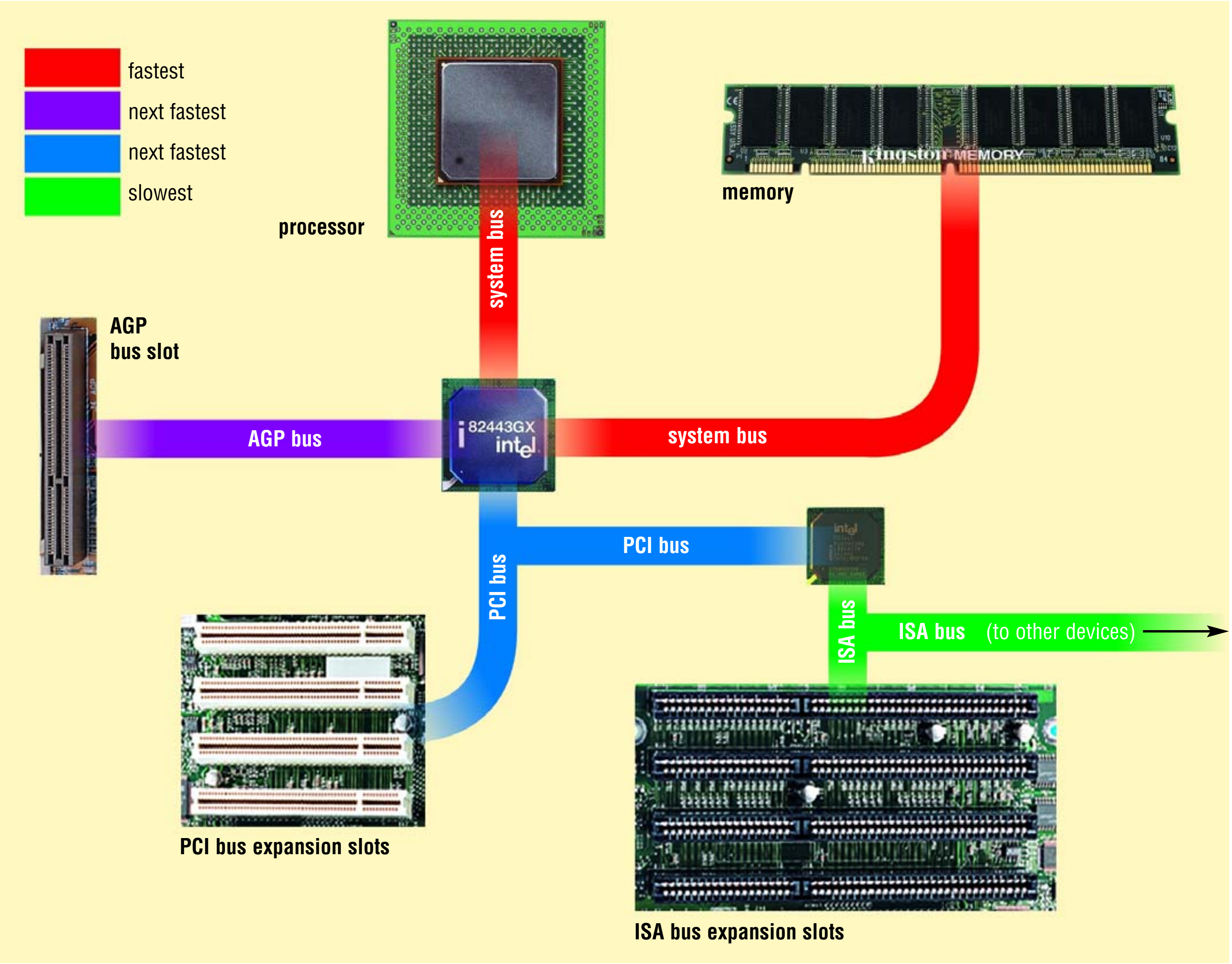


Figure 4-41 Buses allow the various devices inside and attached to the system unit to communicate with each other. Shown here, the buses in order of speed, from fastest to slowest, are the system bus, the AGP bus, the PCI bus, and the ISA bus.

- The **universal serial bus** (**USB**) and **1394 bus** are buses that eliminate the need to install cards into expansion slots. In a computer with a USB, for example, USB devices connect to each other outside the system unit and then a single cable attaches to the USB port. The USB port then connects to the USB, which connects to the PCI bus on the motherboard. The 1394 bus works in a similar fashion. With these buses, expansion slots are available for devices not compatible with USB or 1394.
- The expansion bus for a PC Card is the **PC Card bus**. With a PC Card inserted into a PC Card slot, data travels on the PC Card bus to the PCI bus.

BAYS

After you purchase a computer, you may want to install an additional device such as a disk drive to add storage capabilities to the system unit. A **bay** is an open area inside the system unit in which you can install additional equipment. A bay is different from a slot, which is used for the installation of cards. These spaces, commonly called **drive bays**, most often hold disk drives.

Two types of drive bays exist: internal and external. An **external drive bay** or **exposed drive bay** allows access to the drive from outside the system unit. Floppy disk drives, CD-ROM drives, DVD-ROM drives, Zip® drives, and tape drives are examples of devices installed in external drive bays (Figure 4-42). An **internal drive bay** or **hidden drive bay** is concealed entirely within the system unit. Hard disk drives are installed in internal bays.

POWER SUPPLY

Many personal computers plug into standard wall outlets, which supply an alternating current (AC) of 115 to 120 volts. This type of power is unsuitable for use with a computer, which requires a direct current (DC) ranging from 5 to 12 volts. The **power supply** is the component in the system unit that converts the wall outlet AC power into DC power.

Some external peripheral devices such as an external modem or tape drive have an **AC adapter**, which is an external power supply. One end of the AC adapter plugs into the wall outlet and the other end attaches to the peripheral device. The AC adapter converts the AC power into DC power that the device requires.

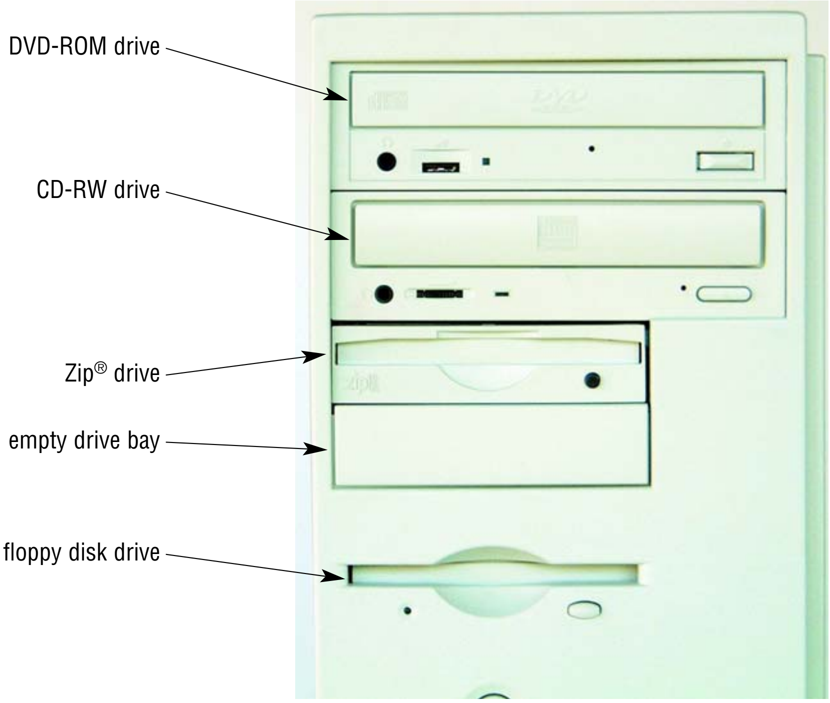


Figure 4-42 Drive bays usually are located beside or on top of one another.

MOBILE COMPUTERS

As businesses expand to serve customers across the country and around the world, more and more people need to use a computer while traveling to and from a main office to conduct business. As noted in Chapter 1, users with such mobile computing needs — known as mobile users — often have a mobile computer such as a notebook and/or handheld computer (Figure 4-43).

Weighing on average between 4 and 10 pounds, notebook computers can run either using batteries or using a standard power supply. Smaller handheld computers, run strictly on battery.

Like their desktop counterparts, notebook computers and handheld computers have a system unit that contains electronic components that processes data (Figure 4-44). The difference is many other devices also are part of the system unit. In addition to the motherboard, processor, memory, sound card, PC Card slot, and drive bay, the system unit also houses devices such as the keyboard, pointing device, speakers, and display.

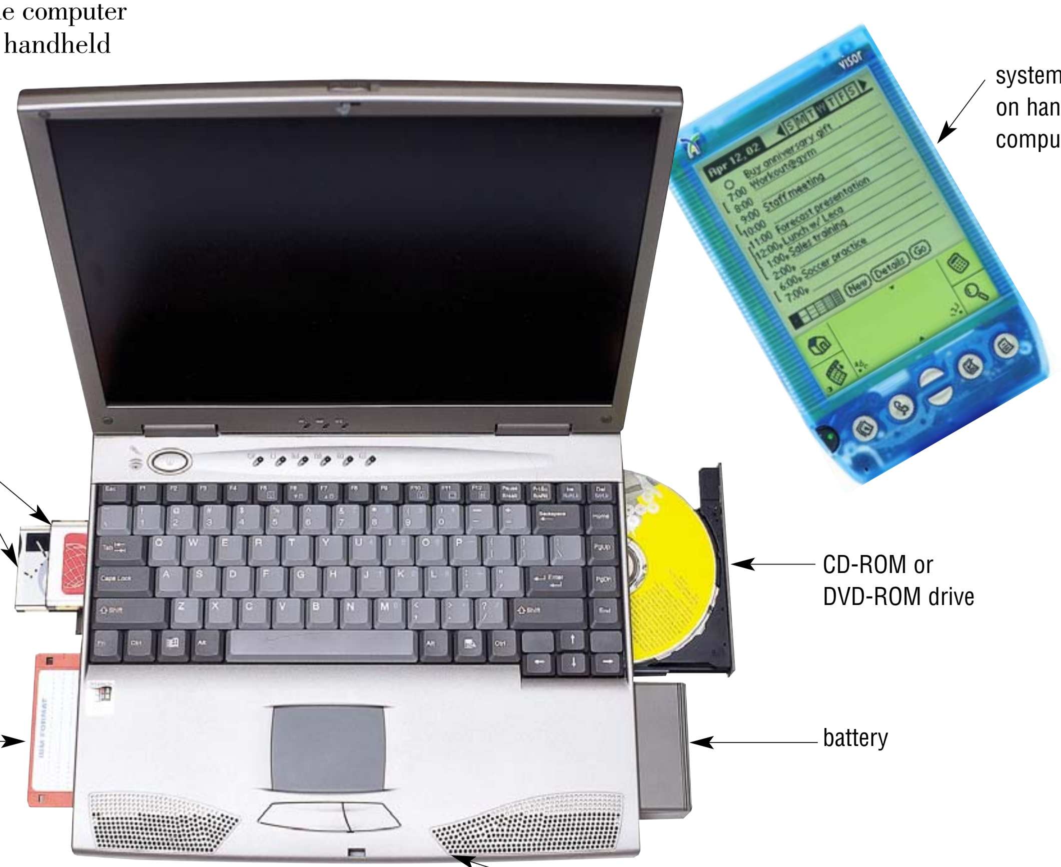
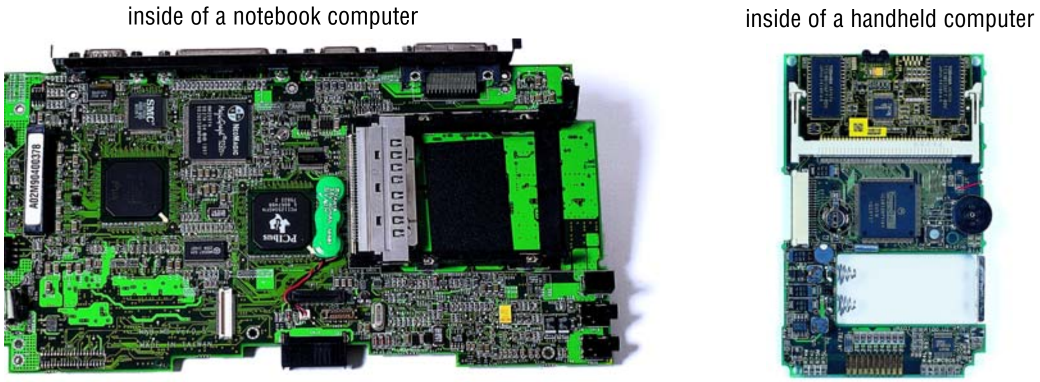

system unit on handheld computer
PC Cards in PC Card slots
CD-ROM or DVD-ROM drive
floppy disk drive or Zip® disk drive
battery
system unit on notebook computer

Figure 4-43 Users with mobile computing needs often have a notebook computer and/or handheld computer.


inside of a notebook computer

inside of a handheld computer

Figure 4-44 Notebook and handheld computers contain electronic components that process data.

A notebook computer usually is more expensive than a desktop computer with the same capabilities. Handheld computers are more affordable, usually costing a few hundred dollars.

The typical notebook computer often has a keyboard/mouse, IrDA, serial, parallel, video, and USB ports (Figure 4-45).

Handheld computers often have an IrDA port so you can communicate wirelessly with other computers or devices such as a printer. Many include a serial port. Handheld computers also can rest in a cradle, so you can transfer data to your desktop computer (Figure 4-46).

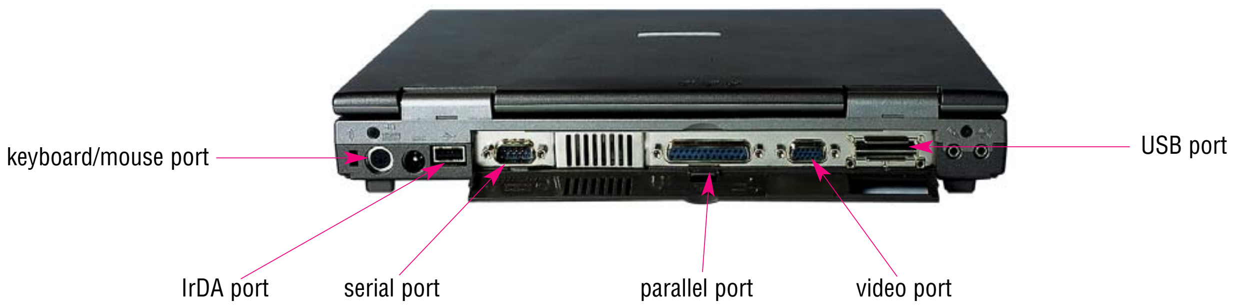


Figure 4-45 A notebook computer often has a keyboard/mouse, IrDA, serial, parallel, video, and USB ports.

ISSUE

On the Go

Mobile Computers

Mobile computers are everywhere. Handheld computers and Web-enabled cellular telephones are ideal for the person on the go. A typical handheld computer can function as a fax sender and personal organizer. Handheld computers often use a stylus instead of a keyboard for input, which allows you to write directly on the device's screen. Thus, many handheld computers incorporate handwriting recognition features. Some handheld computers are capable of voice input using voice recognition technology. Software for many of these devices can turn your handheld organizer into a miniature version of the Web. And, handheld computers are inexpensive. If a mobile device can perform all the same functions, including Web access, of a desktop or notebook computer, is it necessary to spend more money on these higher priced devices? What advantages does a desktop or notebook computer provide? What advantages does a handheld computer provide? Is it necessary to have both a desktop or notebook computer and a handheld computer? Why or why not?

For more information on mobile computers, visit the Discovering Computers 2002 Issues Web page (**scsite.com/dc2002/issues.htm**) and click Chapter 4 Issue #5.

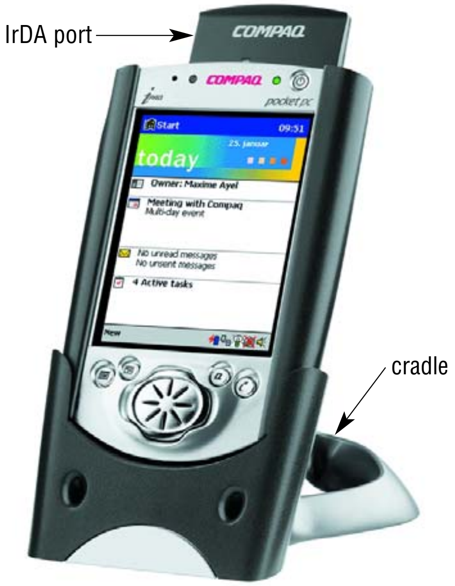


Figure 4-46 You transfer data from a smaller handheld computer, through a cradle or an IrDA port.

PUTTING IT ALL TOGETHER

When purchasing a computer, it is important to understand how the components in the system unit work. Many factors inside the system unit influence the speed and power of a computer. The type of computer configuration you require depends on your intended use. The table in Figure 4-47 lists the suggested processor, clock speed, and RAM requirements based on the needs of various types of computer users.

CHAPTER SUMMARY

Chapter 4 presented the components in the system unit, described how memory stores data, instructions, and information, and discussed the sequence of operations that occur when a computer executes an instruction. The chapter included a comparison of various personal computer processors on the market today.

SUGGESTED CONFIGURATIONS BY USER

USER	PROCESSOR AND CLOCK SPEED	MINIMUM RAM
Home	Pentium® 4 or Athlon™ 600 MHz or higher; or Celeron™ or Duron™ – 600 MHz or higher	64 MB
Small Office/Home Office	Pentium® 4 or Athlon™ – 800 MHz or higher	128 MB
Mobile	Pentium® III or AMD-K6®-2-P 500 MHz or higher	64 MB
Large Business	Pentium® 4 or Athlon™ – 700 MHz or higher	128 MB
Power	Pentium® 4 or Itanium™ or Athlon™ – 1 GHz or higher	256 MB

Figure 4-47 This table recommends suggested processor, clock speed, and RAM configurations.

Software Engineer

Software engineering is a dynamic and exciting field. You have your choice of a number of professions from robotics to operating systems and application software development to personal communications systems to intelligent agents to computer animation to computational biology. In many universities, software engineering is a sub-component of computer science. The field of software engineering is concerned with the processes, methods, and tools for the development of high-quality software systems. Students study the application of software specification, design, implementation, testing, and documentation of software.

A minimum of a bachelor's degree is required to work as a software engineer, but many people continue on for their masters and even a Ph.D. A strong mathematics background is required, and the road to the top of this field is a rigorous one. Expect to work hard and put in many years before you obtain your degree. When you finally achieve your goal, do not relax too quickly; computer science is ever changing. To stay in this field, you can expect to upgrade continually your skills and knowledge. The benefits are worth the effort. Software engineers can expect salaries of $75,000 and up.

To learn more about the field of software engineering as a career, visit the Discovering Computers 2002 Careers Web page (**scsite.com/dc2002/careers.htm**) and click Software Engineering.

E-RESOURCES

LOOK IT UP

Web Resources Ease System Concerns

Have you heard of a Diffie-Hellman or a mouse potato? If you do not know a JDK from an OSS, then an online computer technology dictionary may be the tool you need. From dictionaries and encyclopedias to online technical support, the Web is filled with a plethora of resources, including those listed in Figure 4-48, to answer your computer questions and resolve specialized problems.

Chapter 4 describes the components of the system unit including the different processors, various types of memory, and other devices associated with it, as well as the components of notebook and handheld computers. With the continual developments in technology and communications, new products reach the marketplace daily.

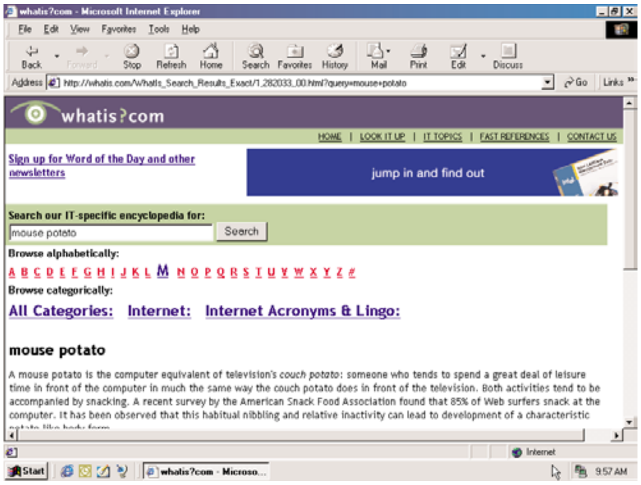
A way to keep up with the latest developments is to look to online dictionaries that add to their collections of computer and product terms on a regular basis and include thousands of descriptions and designations. An example is the whatis?com Web site listed in the table in Figure 4-48 and shown in Figure 4-49. The whatis?com Web site contains more than 2,500 cyberterms, with daily updates to the words and definitions. This Web site and many other reference Web pages feature a word of the day that identifies a new product or industry standard as well as highlight recently added or revised terms.

Shopping for a new computer can be a daunting experience, but many online guides can help you select the components that best fit your needs and budget. Most of these Web sites, including NetGuide (Figure 4-50),

RESOURCES WEB SITES	URL
Dictionaries and Encyclopedias	
CDT's Guide to Online Privacy	www.cdt.org/privacy/guide/terms
ComputerUser High-Tech Dictionary	computeruser.com/resources/dictionary
Webopedia: Online Computer Dictionary for Internet Terms and Technical Support	webopedia.com
whatis?com	whatis.com
ZD Webopædia	www.zdwebopedia.com
Computer Shopping Guides	
BizRate.com®	bizrate.com/marketplace
Computer Shopper	zdnet.com/computershopper
NetGuide	netguide.com
The CPU Scorecard	cpuscorecard.com
The Online Computer Buying Guide™	grohol.com/computers
Upgrading Guides	
CNET Shopper	shopper.cnet.com
eHow™	ehow.com
PC World.com	pcworld.com/heres_how
Upgrade Source	upgradesource.com
Focus on MacSupport	macsupport.miningco.com/compute/macsupport
Online Technical Support	
Dux Computer Digest	duxcw.com
MSN Computing Central	computingcentral.msn.com
PC911	pcnineoneone.com
PC-Help Online	pchelponline.com
Learnlots.com	www.learnlots.com
Technical and Consumer Information	
CNET	cnet.com
newsday.com	newsday.com/plugin/c101main.htm
The Standard.com	thestandard.com
Wired News	wirednews.com
ZDNet	zdnet.com

For an updated list of resources Web sites, visit scsite.com/dc2002/e-rev.htm.

Figure 4-48 A variety of Web resources can provide information on buying, repairing, and upgrading computers.


whatis?com - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Forward Stop Refresh Home Search Favorites History Mail Print Edit Discuss
Address
Go Links
whatis?com
HOME | LOOK IT UP | IT TOPICS | FAST REFERENCES | CONTACT US
Sign up for Word of the Day and other newsletters
jump in and find out
Search
Browse alphabetically:
A B C D E F G H I J K L M N O P Q R S T U V W X Y Z #
Browse categorically:
All Categories: Internet: Internet Acronyms & Lingo:
Internet
Start
whatis?com - Microso...
9:57 AM

Address: http://whatis.com/WhatIs_Search_Results_Exact/1,282033,00.html?query=mouse+potato

Search our IT-specific encyclopedia for: mouse potato

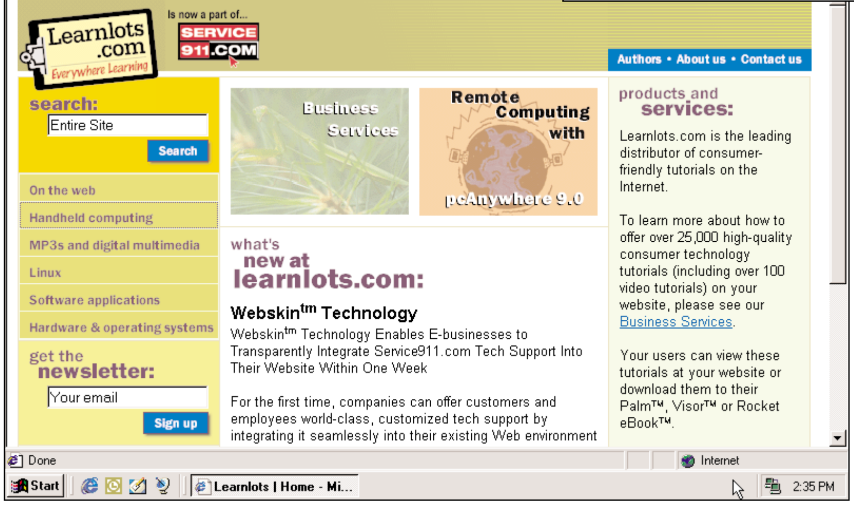
mouse potato

A mouse potato is the computer equivalent of television's *couch potato*: someone who tends to spend a great deal of leisure time in front of the computer in much the same way the couch potato does in front of the television. Both activities tend to be accompanied by snacking. A recent survey by the American Snack Food Association found that 85% of Web surfers snack at the computer. It has been observed that this habitual nibbling and relative inactivity can lead to development of a characteristic

Figure 4-49 Thousands of technology terms are defined at the whatis?com Website.

feature the latest desktop and notebook computer prices, hardware reviews, bargains, and links to popular manufacturers' sale Web pages. If you want to upgrade your present computer, several online guides, such as CNET Shopper and Upgrade Source, give current prices for these components and list the more popular products.

If you are not confident in your ability to work a problem alone, turn to online technical support. Such Web sites, including Learnlots.com (Figure 4-51), often provide streaming how-to video lessons, tutorials, and real-time chats with experienced technicians.


Learnlots | Home - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Forward Stop Refresh Home Search Favorites History Mail
Address http://www.learnlots.com/
Learnlots.com Everywhere Learning
Is now a part of...
SERVICE 911.COM
Authors • About us • Contact us
search:
Entire Site
Search
On the web
Handheld computing
MP3s and digital multimedia
Linux
Software applications
Hardware & operating systems
get the newsletter:
Your email
Sign up
Business Services
Remote Computing with pcAnywhere 9.0
Done
Internet
Start
Learnlots | Home - Mi...
2:35 PM

what's new at learnlots.com:

Webskin^{tm} Technology

Webskin^{tm} Technology Enables E-businesses to Transparently Integrate Service911.com Tech Support Into Their Website Within One Week

For the first time, companies can offer customers and employees world-class, customized tech support by integrating it seamlessly into their existing Web environment

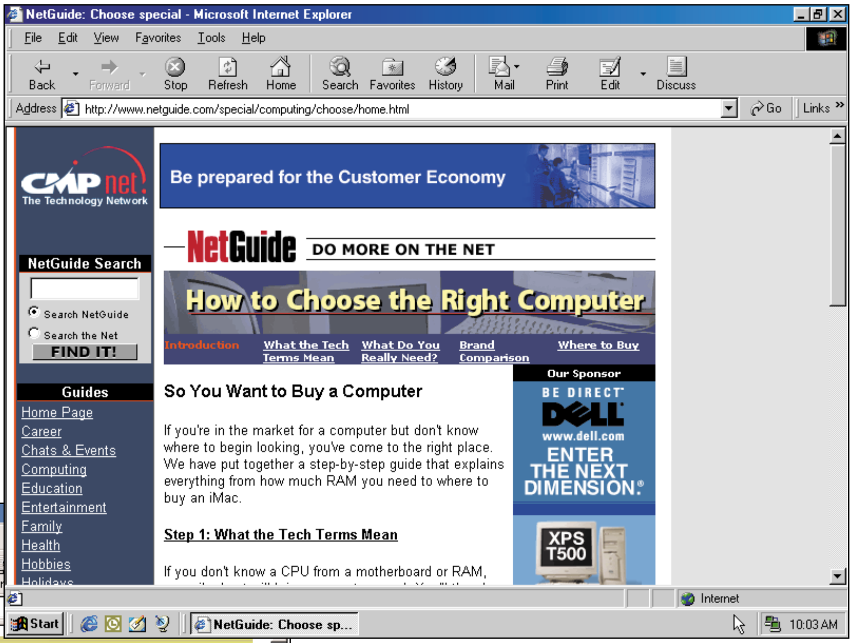
products and services:

Learnlots.com is the leading distributor of consumer-friendly tutorials on the Internet.

To learn more about how to offer over 25,000 high-quality consumer technology tutorials (including over 100 video tutorials) on your website, please see our Business Services.

Your users can view these tutorials at your website or download them to their Palm™, Visor™ or Rocket eBook™.

Figure 4-51 Practical tutorials at the Learnlots.com Web site provide useful technological information.


NetGuide: Choose special - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Forward Stop Refresh Home Search Favorites History Mail Print Edit Discuss
Address http://www.netguide.com/special/computing/choose/home.html
Go
Links
CMP net. The Technology Network
Be prepared for the Customer Economy
NetGuide DO MORE ON THE NET
NetGuide Search
Search NetGuide
Search the Net
FIND IT!
How to Choose the Right Computer
Introduction
What the Tech Terms Mean
What Do You Really Need?
Brand Comparison
Where to Buy
Guides
Home Page
Career
Chats & Events
Computing
Education
Entertainment
Family
Health
Hobbies
Holidays
Our Sponsor
BE DIRECT DELL www.dell.com
ENTER THE NEXT DIMENSION.
XPS T500
Internet
Start
NetGuide: Choose sp...
10:03 AM

So You Want to Buy a Computer

If you're in the market for a computer but don't know where to begin looking, you've come to the right place. We have put together a step-by-step guide that explains everything from how much RAM you need to where to buy an iMac.

Step 1: What the Tech Terms Mean

If you don't know a CPU from a motherboard or RAM,

Figure 4-50 Buying and upgrading a computer is simplified with helpful Web sites such as NetGuide.

The Web offers a variety of technical and consumer information. Hardware and software reviews, price comparisons, shareware, technical questions and answers, and breaking technology news are found on comprehensive portals such as CNET and ZDNET.

For more information on Web resources sites, visit the Discovering Computers 2002 E-Revolution Web page (scsite.com/dc2002/e-rev.htm) and click Resources.

eREVOLUTION E-RESOURCES applied:

1. Visit the dictionary and encyclopedia Web sites listed in Figure 4-48. Search these resources for five terms. Create a table with two columns: one for the cyberterm and one for the Web definition. Then, create a second table listing five recently added or updated words and their definitions on these sites. Next, visit two of the listed computer shopping guide Web sites to choose the components you would buy if you were building a customized desktop computer and notebook computer. Create a table for both systems listing the computer manufacturer, processor model name or number and manufacturer, clock speed, RAM, cache, number of expansion slots, and number of bays.

2. Visit three upgrading guide Web sites listed in Figure 4-48. Write a paragraph describing available advice for buying a motherboard. Describe the strengths and weaknesses of these Web sites, focusing on such criteria as clarity of instructions, thoroughness, and ease of navigation. Would you use these Web sites as a resource to troubleshoot computer problems? Then, view two technical and consumer information Web sites listed in the table and write a paragraph on each describing the top two news stories of the day.

In Summary

Web Instructions: To display this page from the Web, start your browser and enter the URL scsite.com/dc2002/ch4/summary.htm. Click the links for current and additional information. To listen to an audio version of this In Summary, click the Audio button. To play the audio, RealPlayer must be installed on your computer (download by clicking here).

1

What Are the Components in the System Unit?

The **system unit**, sometimes called a **chassis**, is a box-like case that houses the electronic components of a computer that are used to process data. System unit components include the processor, memory module, expansion cards, ports, and connectors. Many components reside on a circuit board called the **motherboard**, or **system board**. The motherboard contains different types of **chips**, or small pieces of semi-conducting material on which one or more **integrated circuits** (**IC**) are etched. A **transistor** acts as an electronic gate that opens or closes the circuit for electronic signals. One of the more important chips is the central processing unit (CPU).

2

How Does the CPU Process Data?

The **central processing unit** (**CPU**), sometimes referred to as the **processor**, interprets and carries out the basic instructions that operate a computer. The **control unit**, which is one component of the CPU, directs and coordinates most of the operations in the computer. For every instruction, the control unit repeats a set of four basic operations called the **machine cycle**: (1) **fetching** the instruction or data item from memory; (2) **decoding** the instruction into commands the computer understands; (3) **executing**, or carrying out, the commands; and, if necessary, (4) **storing**, or writing, the result to memory. The **arithmetic/logic unit** (**ALU**), another component of the CPU, performs the arithmetic, comparison, and logical operations.

3

What Are Some Processors Available Today?

A personal computer's CPU usually is contained on a single chip called a **processor**. Intel, a leading manufacturer of processors, produces **Pentium®** processors for high-end personal computers, the **Celeron™** processor for less expensive personal computers, and the **Xeon™** and **Itanium™** processors for workstations and servers. **Intel-compatible processors** have the same internal design as Intel processors and perform the same functions, but are made by other companies and often are less expensive. The **Motorola processor** is an alternative to the Intel-style processor and is found in Apple Macintosh and Power Macintosh systems. The **Alpha processor**, originally from Digital Equipment Corporation, is used primarily in workstations and high-end servers. A new type of processor, called an **integrated CPU**, combines functions of a CPU, memory, and a video card on a single chip.

4

How Do Series of Bits Represent Data?

Most computers are **digital**, meaning they understand only two discrete states: on and off. These states are represented using two digits, 0 (off) and 1 (on). Each on or off value is called a **bit** (short for **bi**nary digi**t**), which is the smallest unit of data a computer can handle. Eight bits grouped together as a unit are called a **byte**. A byte can represent 256 individual characters including numbers, letters of the alphabet, punctuation marks, and other characters. Combinations of 0s and 1s used to represent data are defined by patterns called coding schemes. Popular coding schemes are **ASCII**, **EBCDIC**, and **Unicode**.

5

What Are Different Types of Memory?

In the processor, a computer's **memory** stores data, instructions, and information. Memory and storage size are measured by the number of bytes — a **kilobyte** (**K** or **KB**) is approximately one thousand bytes, a **megabyte** (**MB**) is approximately one million bytes, and a **gigabyte** (**GB**) is approximately one billion bytes. **RAM** (**random access memory**) consists of memory chips that can be read from and written to by the processor and other devices. Two types of RAM chips exist: **dynamic RAM** (**DRAM**), which must be reenergized constantly; and **static RAM** (**SRAM**), which must be reenergized less often but is more expensive. Most computers improve processing times by using **memory cache** to store frequently used instructions and data. **ROM** (**read-only memory**) is a memory chip that only can be read; it cannot be modified. **Flash memory**, also called **flash ROM** or **flash RAM**, is nonvolatile memory that can be erased electronically and reprogrammed. **CMOS** memory is used to store configuration information about the computer.

6

What Are Expansion Slots and Expansion Cards?

An **expansion slot** is an opening, or socket, where a circuit board can be inserted into the motherboard. These circuit boards, sometimes referred to as **expansion boards** or **expansion cards** and several other terms, are used to add new devices or capabilities to the computer, such as a modem or more memory. **Plug and Play** refers to a computer's capability of automatically configuring expansion cards and other devices as they are installed.

7

How Are Serial Ports, Parallel Ports, and USB Ports Different?

A cable often attaches external devices to the system unit. The interface, or point of attachment, to the system unit is called a **port**. Ports have different types of **connectors** used to join a cable to a device. A **serial port** is an interface that transmits only one bit of data at a time. Serial ports usually connect devices that do not require fast data transmission rates, such as a mouse, keyboard, or modem. A **parallel port** is an interface used to connect devices that are capable of transferring more than one bit at a time. Many printers connect to the system unit using a parallel port. A **universal serial bus** (**USB**) **port** can connect up to 127 different peripheral devices with a single connector type. To attach multiple devices to a single port, you daisy chain the devices.

8

How Do Buses Contribute to a Computer's Processing Speed?

Bits are transferred internally within the circuitry of the computer along electrical channels. Each channel, called a **bus**, allows various devices inside and attached to the system unit to communicate with each other. The **bus width**, or size of the bus, determines the number of bits that can be transferred at one time. The larger the bus width, the faster the computer transfers data. **Word size** is the number of bits the CPU can process at one time.

9

What Are the Components in a Notebook Computer?

Notebook computers have a system unit that contains electronic components — the same as those found in a desktop computer. Additionally, the system unit houses the keyboard, pointing device, speakers, and display. A notebook computer often has serial, parallel, keyboard, mouse, USB, video, and IrDA ports.

10

What Are the Components in a Handheld Computer?

Handheld computers have a system unit that contains electronic components — the same as those found in a desktop computer. Most handheld computers contain an IrDA port to communicate with other handheld computers, desktop and notebook computers, or devices such as a printer.

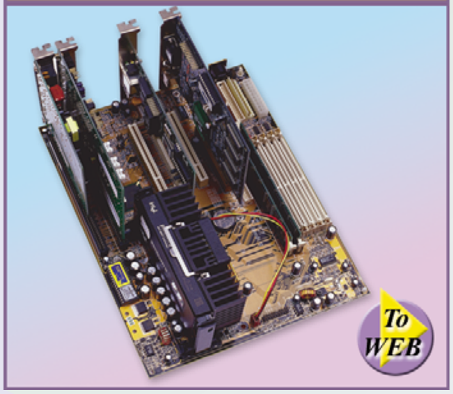
Key Terms

Web Instructions: To display this page from the Web, start your browser and enter the URL scsite.com/dc2002/ch4/terms.htm. Scroll through the list of terms. Click a term to display its definition and a picture. Click the To WEB button for current and additional information about the term from the Web. To see animations, Shockwave and Flash Player must be installed on your computer (download by clicking here).

1394 bus (4.32)
1394 port (4.28)
3DNow!™ (4.11)
AC adapter (4.32)
Accelerated Graphics Port (AGP) (4.31)
access time (4.22)
adapter (4.23)
adapter card (4.23)
add-in (4.23)
add-on (4.23)
advanced transfer cache (4.20)
all-in-one computer (4.3)
Alpha processor (4.10)
American Standard Code for Information Interchange (4.14)
analog (4.13)
arithmetic operations (4.6)
arithmetic/logic unit (ALU) (4.6)
ASCII (4.14)
basic input/output system (BIOS) (4.20)
bay (4.32)
binary system (4.14)
bit (4.14)
board (4.23)
bus (4.29)
bus width (4.29)
byte (4.14)
cache (4.19)
cache store (4.19)
card (4.23)
Celeron™ (4.10)
central processing unit (CPU) (4.5)
chassis (4.2)
chip (4.4)
chip for chip upgrade (4.11)
CISC (complex instruction set computing) (4.6)
clock cycle (4.8)
clock rate (4.8)
clock speed (4.8)
CMOS (4.21)
comparison operations (4.6)
complementary metal-oxide semiconductor memory (4.21)
connector (4.26)
control unit (4.5)
coprocessor (4.13)
daughterboard (4.11)
daughterboard upgrade (4.11)
decoding (4.5)
digital (4.13)
Direct Rambus® DRAM (Direct RDRAM®) (4.18)
double data rate SDRAM (DDR SDRAM) (4.18)
DRAM (4.18)
drive bays (4.32)
dual inline memory module (DIMM) (4.18)
dual inline package (DIP) (4.4)
dynamic RAM (4.18)
EBCDIC (4.14)
EEPROM (electrically erasable programmable read-only memory) (4.20)
executing (4.5)
execution time (e-time) (4.6)
expansion board (4.23)
expansion bus (4.30)
expansion card (4.23)
expansion slot (4.23)
exposed drive bay (4.32)
Extended Binary Coded Decimal Interchange Code (4.14)
external cache (4.19)
external drive bay (4.32)
female connectors (4.26)
fetching (4.5)
FIR (fast infrared) (4.29)
FireWire (4.28)
firmware (4.20)
flash BIOS (4.21)
flash memory (4.21)
flash memory cards (4.21)
flash RAM (4.21)
flash ROM (4.21)
flip chip-PGA (FC-PGA) package (4.4)
floating-point coprocessor (4.13)
gender changer (4.27)
gigabyte (GB) (4.16)
gigahertz (GHz) (4.8)
graphics card (4.23)
heat pipe (4.12)
heat sink (4.12)
hertz (4.8)
hidden drive bay (4.32)
hot plugging (4.25)

SYSTEMBOARD

Circuit board that contains most of the electronic components in the system unit. Also called motherboard. (4.4)



hot swapping (4.25)
IEEE 1284 (4.28)
instruction cycle (4.6)
instruction time (i-time) (4.6)
integrated circuit (IC) (4.4)
integrated CPU (4.11)
Intel-compatible processors (4.10)
interface card (4.23)
internal cache (4.19)
internal drive bay (4.32)
internal modem (4.23)
IrDA (Infrared Data Association) (4.29)
IrDA port (4.29)
ISA (Industry Standard Architecture) bus (4.31)
Itanium™ (4.10)
K (4.16)
KB (4.16)
kilobyte (4.16)
L3 cache (4.20)
Level 1 (L1) cache (4.19)
Level 2 (L2) cache (4.19)
local bus (4.31)
logical operations (4.7)
machine cycle (4.6)
main memory (4.18)
male connectors (4.26)
megabyte (MB) (4.16)
megahertz (MHz) (4.8)
memory (4.15)
memory cache (4.19)
memory module (4.18)
microcode (4.20)
microprocessor (4.9)
MIDI (4.28)
MIPS (4.6)
MMX™ (multimedia extensions) (4.11)
modem card (4.23)
motherboard (4.4)
Motorola processor (4.10)
musical instrument digital interface (4.28)
nanosecond (ns) (4.22)
network card (4.23)
network interface card (NIC) (4.23)
nonvolatile memory (NVM) (4.16)
parallel port (4.27)
parallel processing (4.13)
PC Card (4.24)
PC Card bus (4.32)
PCI (Peripheral Component Interconnect) bus (4.31)
PCMCIA cards (4.27)
Pentium® (4.10)
piggyback upgrade (4.11)
pin grid array (PGA) package (4.4)
pipelining (4.7)
Plug and Play (4.24)
port (4.25)
power supply (4.32)
primary cache (4.19)
processor (4.5)
programmable read-only memory (PROM) (4.20)
RAM (random access memory) (4.16)
RAM cache (4.19)
Rambus® inline memory module (RIMM) (4.18)
read-only memory (ROM) (4.20)
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RISC (reduced instruction set computing) (4.6)
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SDRAM II (4.18)
serial port (4.27)
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tower models (4.3)
transistor (4.4)
Type I cards (4.24)
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Unicode (4.14)
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Learn It Online

Web Instructions: To display this page from the Web, start your browser and enter the URL scsite.com/dc2002/ch1/learn.htm.

1. Web Guide

Click Web Guide to display the Guide to World Wide Web Sites and Searching Techniques Web page. Click Computers and Computing and then click Virtual Museum of Computing. Scroll down the page and locate General Historical Information. Click a link of your choice. Use your word processing program to prepare a brief report on your tour and submit your assignment to your instructor.

2. Scavenger Hunt

Click Scavenger Hunt. Print a copy of the Scavenger Hunt page; use this page to write down your answers as you search the Web. Submit your completed page to your instructor.

3. Who Wants to Be a Computer Genius?

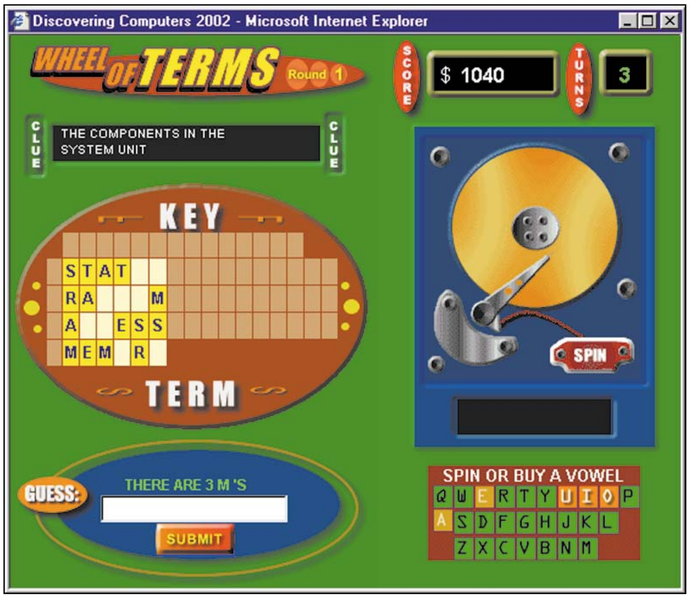
Click Computer Genius to find out if you are a computer genius. Directions on how to play the game will display. When you are ready to play, click the PLAY button. Submit your score to your instructor.

4. Wheel of Terms

Click Wheel of Terms to reinforce important terms you learned in this chapter by playing the Shelly Cashman Series version of this popular game. Directions on how to play the game will display. When you are ready to play, click the PLAY button. Submit your score to your instructor.

5. Career Corner

Click Career Corner to display the Making College Count page. Click a link of your choice and review the page. Write a brief report describing what you learned. Submit the report to your instructor.



6. Search Sleuth

Click Search Sleuth to learn search techniques that will help make you a research expert. Submit the completed assignment to your instructor.

7. Crossword Puzzle Challenge

Click Crossword Puzzle Challenge. Complete the puzzle to reinforce skills you learned in this chapter. Directions on how to play the game will display. When you are ready to play, click the PLAY button. Submit the completed puzzle to your instructor.

8. Practice Test

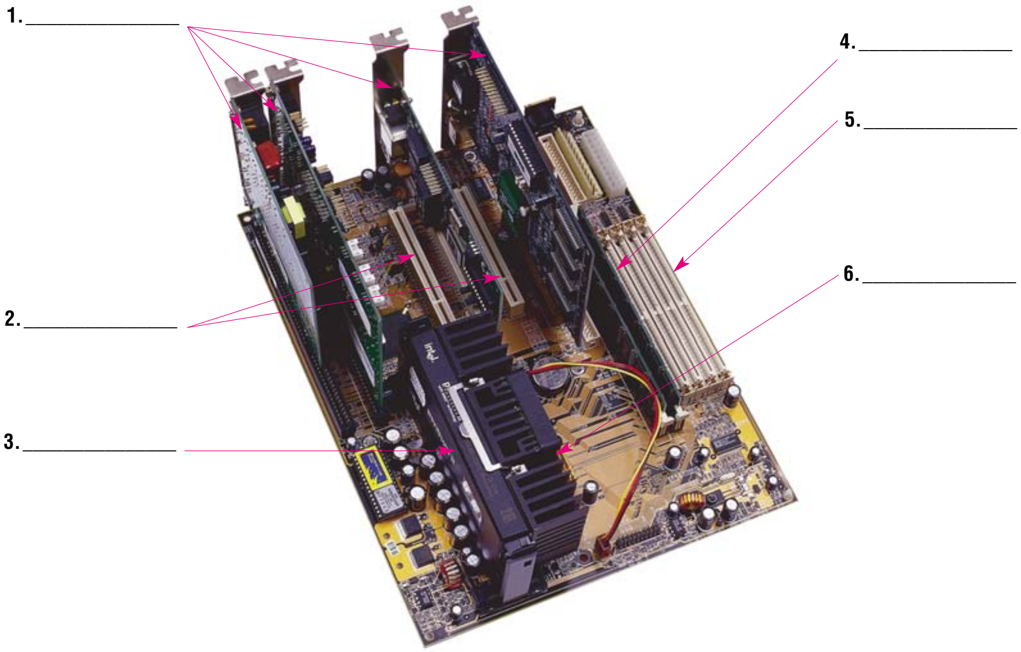
Click Practice Test. Answer each question. When completed enter your name and click the Grade Test button to submit the quiz for grading. Make a note of any missed questions. If required, print a copy to submit to your instructor.

Checkpoint

Web Instructions: To display this page from the Web, start your browser and enter the URL scsite.com/dc2002/ch4/check.htm. Click the links for current and additional information. To experience the animation and interactivity, Shockwave and Flash Player must be installed on your computer (download by clicking here.)

LABEL THE FIGURE

Instructions: Identify these components of the motherboard.



MATCHING

Instructions: Match each term from the column on the left with the best description from the column on the right.

_______1. PC card
_______2. sound card
_______3. expansion slot
_______4. video card
_______5. network interface card

a. Converts computer output into a video signal.
b. A communications device that allows the computer to communicate via a network.
c. Enhances the sound-generating capabilities of a personal computer.
d. A device that can connect up to 127 different peripheral devices with a single connector type.
e. A device that enables you to join two connectors that are either both female or both male.
f. A thin, credit card-sized device.
g. An opening, or socket, where you can insert a circuit board into the motherboard.

Checkpoint

MULTIPLE CHOICE

Instructions: Select the letter of the correct answer for each of the following questions.

1. A(n) ___________ is a small piece of semi-conducting material on which one or more integrated circuits are etched.
   a. chip
   b. system board
   c. control unit
   d. arithmetic/logic unit
2. The process of translating instructions into commands is called ___________ .
   a. fetching
   b. decoding
   c. executing
   d. storing
3. Most RAM is ___________ .
   a. volatile
   b. nonvolatile
   c. read-only
   d. both a and c
4. A ___________ cache helps speed the processes of the computer by storing frequently used instructions and data.
   a. disk
   b. memory
   c. ROM
   d. PROM
5. A ___________ port can support up to 127 different devices.
   a. serial
   b. parallel
   c. SCSI
   d. USB

SHORT ANSWER

Instructions: Write a brief answer to each of the following questions.

1. What is the purpose of the CPU? ___________ What is the control unit's job? ___________ What are the four basic operations? ___________
2. How is instruction time, or i-time, different from execution time, or e-time? ___________ In what unit is a computer's speed measured? ___________
3. How are arithmetic operations, comparison operations, and logical operations different? ___________ In what part of the CPU do these operations occur? ___________
4. What are some of the different processors used in today's personal computers? ___________ What is a new type of processor? ___________
5. How are the components different among a desktop computer, a notebook computer, and a handheld computer? ___________

WORKING TOGETHER

Instructions: Working with a group of your classmates, complete the following team exercise.

Prepare a report on the different types of ports and the way you connect peripheral devices to a computer. As part of your report, include the following subheadings and an overview of each subheading topic: (1) What is a port? (2) What is a connector? (3) What is a serial port and how does it work? (4) What is a parallel port and how does it work? (5) What is a USB port and how does it work? Expand your report so that it includes information beyond that in your textbook. Create a PowerPoint presentation from your report.

In The Lab

Web Instructions: To display this page from the Web, start your browser and enter the URL scsite.com/dc2002/ch4/lab.htm. Click the links for current and additional information.

Installing New Hardware

1

This exercise uses Windows 98 procedures. Plug and Play technology, a key feature of the Windows operating system, allows users to install new devices without having to reconfigure the system manually. To find out how to install a new device with Plug and Play technology, click the Start button on the taskbar, and then click Help on the Start menu. When the Windows Help window displays, if necessary, click the Contents tab. Click the Managing Hardware and Software book and then click the Installing New Hardware and Software book. Click Install a Plug and Play device.

- What are the three steps in installing a Plug and Play device?
- When would Windows not detect a Plug and Play device?
- How is a device that is not Plug and Play installed?

Close Windows Help.

Setting the System Clock

2

Double-click the time on the taskbar. In the Date/Time Properties dialog box, click the Question Mark button on its title bar, and then click the picture of the calendar. Read the information in the pop-up window and then click the pop-up window to close it. Repeat this process for other areas of the dialog box and then answer these questions:

- What is the purpose of the calendar?
- How do you change the time zone?
- What is the difference between the Close and Apply buttons?

Close the Date/Time Properties dialog box.

Using Calculator to Perform Number System Conversion

3

Instead of the decimal (base 10) number system that people use, computers use the binary (base 2) or hexadecimal (base 16) number systems. It is not necessary to understand these number systems to use a computer, but it is interesting to see how decimal numbers look when in binary or hexadecimal form. Click the Start button on the taskbar, point to Programs on the Start menu, point to Accessories on the Programs submenu, and then click Calculator on the Accessories submenu. Click View on the menu bar and then click Scientific to display the scientific calculator. Perform the following tasks:

- Click Dec to select decimal. Enter 35 by clicking the numeric buttons or using the numeric keypad. Click Bin to select binary. What number displays? Click Hex to select hexadecimal. What number displays? Click the C (Clear) button.
- Convert the following decimal numbers to binary and hexadecimal: 7,256, and 3,421.
- What decimal number is equal to 10010 in the binary system? What decimal number is equal to 2DA9 in the hexadecimal system?

Close the Calculator window.

Power Management

4

This exercise uses Windows 98 or Windows 2000 procedures. Environmental and financial considerations make it important to manage the amount of power a computer uses. Click the Start button on the taskbar, point to Settings on the Start menu, and then click Control Panel on the Settings submenu. Double-click the Power Management icon in the Control Panel window. In the Power Management Properties dialog box, if necessary, click the Power Schemes tab.

- What is a power scheme?
- What power scheme currently is being used on your computer?
- After how many minutes of inactivity is the monitor turned off?
- After how many minutes of inactivity are the hard disks turned off?

Close the Power Management Properties dialog box and the Control Panel window. How can the Power Management Properties dialog box be used to make a computer more energy efficient?

Web Work

Web Instructions: To display this page from the Web, start your browser and enter the URL scsite.com/dc2002/ch4/web.htm. To view At The Movies in exercise 1, RealPlayer must be installed on your computer (download by clicking here). To use the Shelly Cashman Series Understanding the Motherboard Lab from the Web, Shockwave and Flash Player must be installed on your computer (download by clicking here).

1

Andrew Grove

To view the Andrew Grove movie, click the button to the left or click the Play button to the right. Watch the movie, and then complete the exercise by answering the question below. Intel is the leading manufacturer of processors, including the Pentium®, Celeron™, and Xeon™ processors. Intel grew to its present size with more than 60,000 employees because of the outstanding leadership of Andrew Grove. Based on the personal information you learned about Mr. Grove in the movie, describe how his early life struggles, his strong work ethic, and his vision of capitalizing on business trends have been the foundation for Intel's worldwide processor empire. How might Andrew Grove's forward-growth visions for Intel continue to drive the company toward even greater success in the future?

2

Shelly Cashman Series Understanding the Motherboard Lab

Follow the appropriate instructions in Web Work 2 on page 1.47 to start and use the Shelly Cashman Series Understanding the Motherboard Lab. If you are running from the Web, enter the URL scsite.com/sclabs/menu.htm, or display the Web Work page (see instructions at the top of this page) and then click the button to the left.

3

How a Processor Works

After reading about what a processor does and the way it interacts with other system unit components, it still can be difficult to understand how a processor performs even a simple task such as adding two plus three. Click the button to the left, and complete this exercise to learn what a processor does to find the answer.

4

Newsgroups

Would you like more information about a special interest? Perhaps you would like to share opinions and advice with people who have the same interests. If so, you might be interested in newsgroups, also called discussion groups or forums. A newsgroup offers the opportunity to read articles on a specific subject, respond to the articles, and even post your own articles. Click the button to the left to find out more about newsgroups. What is lurking? What is Usenet? Click the how do I find a newsgroup? link at the bottom of the page. Read and print the how do I find a newsgroup? Web page. How can you locate a newsgroup on a particular topic?

5

In the News

The ENIAC (Electronic Numerical Integrator and Computer) often is considered the first modern computer. Invented in 1946, the ENIAC weighed 30 tons and filled a 30-by-50-foot room, yet its capabilities are dwarfed by current notebook computers. The ENIAC performed fewer than 1,000 calculations per minute; today, personal computers can process more than 300 million instructions per second. The rapid development of computing power and capabilities is astonishing, and that development is accelerating. Click the button to the left and read a news article about the introduction of a new or improved computer component. What is the component? Who is introducing it? Will the component change the way people use computers? If so, how?